CLEAN AIR ACT

HEARINGS
BEFORE THE
SUBCOMMITTEE ON
ENERGY DEVELOPMENT AND APPLICATIONS
AND THE
SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
OF THE
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CLEAN AIR ACT

TUESDAY, MAY 19, 1981

U.S. HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS, AND THE SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT,

Washington, D.C.

The subcommittees met at 10:10 a.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the subcommittee on Energy Development and Applications) presiding.

Present: Representatives Fuqua, Scheuer, Young, Fish, Sensenbrenner, Gregg, Skeen, Schneider, McGrath, Dunn, and Walgren.

Mr. FUQUA [presiding]. The subcommittees will be in order.

The subject of these hearings is the status and direction of research and development under the Clean Air Act. Today we will receive testimony from representatives of the National Commission on Air Quality, the business, and environmental communities. Today's witnesses will present the subcommittees—the Subcommittee on Energy Development and Applications and the Subcommittee on Natural Resources, Agriculture Research and Environment—with their perspectives on the overall status of research and development under the Clean Air Act and where this program should be headed in the future.

Tomorrow and on Thursday, the subcommittees will explore some specific research and development issues in this context. Health effects and emphasis on control and monitoring of precombustion technology research and development will be addressed tomorrow afternoon.

On May 28, the subcommittees will look at three new research development issues under the Clean Air Act—acid rain, indoor air pollution, and pollution from synthetic fuels technology. The Committee on Science and Technology has previously held hearings relating to the Clean Air Act in a number of areas, and this year, when the Congress is to reauthorize it, it is important for this Committee to examine the status of scientific and technological research and development in the areas of air pollution.

The National Commission on Air Quality issued its final report in March 1981 as directed by Congress. Much of that document addresses research and development. Mr. Richard Penna, the Commission's Assistant Director for Research, is here today to explain the Commission's findings and recommendations in this area. It is in the context of the Commission's report that Congress intends to debate the reauthorization of the Clean Air Act.

Finally, in a time of need for fiscal restraint, the committee must carefully examine federally supported air pollution research and development to insure that Government funds are well spent in this area.

The testimony received today and on subsequent days of these hearings will help Congress in setting priorities for research and development under the act.

I would like at this time to introduce the witness panel, which consists of Dr. Richard Penna, Assistant Director for Research, National Commission on Air Quality; Mr. David Swan of the Kennecott Corp.; Mr. Michael Oppenheimer of the Environmental Defense Fund.

Gentlemen, we are happy to have you, and Mr. Penna, I believe you are going to lead off.

STATEMENTS OF DR. RICHARD A. PENNA, ASSISTANT DIRECTOR FOR RESEARCH, NATIONAL COMMISSION ON AIR QUALITY; DR. DAVID SWAN, VICE PRESIDENT, KENNECOTT CORP., STAMFORD, CONN.; AND DR. MICHAEL OPPENHEIMER, ENVIRONMENTAL DEFENSE FUND, NEW YORK, N.Y.

Dr. PENNA. Thank you, Mr. Chairman and members of the committee. I would like to thank the subcommittees for inviting me to testify this morning, consistent with the charter of this series of hearings. I will provide a brief overview of four topics: First, the research for national ambient air quality standards and national emission standards for hazardous air pollutants; second, research activities for air quality monitoring and measurements; third, research activities for air pollution control devices; and finally, research activities for emerging issues such as long-distance transport of pollutants, carbon dioxide, and indoor air pollution.

The bases of the vast majority of the testimony I will provide today are the findings and recommendations contained in the final report of the National Commission on Air Quality. This was submitted to each of the members on the 1st of March, and it goes into a fair amount of detail on many aspects of the clean air program, including research and development.

Until the Commission went out of existence on May 1, 1981, I served as Assistant Director of the Commission's staff with primary responsibility for developing and managing the research activities of the Commission.

One of the specific requirements contained in the Commission's authorizing legislation is to report to Congress on "the adequacy of research, development and demonstrating being carried out by Federal, State, and local and nongovernmental entities to protect and enhance air quality." Section 323(a)(5) of the Clean Air Act of 1977; 42 U.S.C. 7623(a)(5). My remarks this morning will be limited to this aspect of the Commission's report. I would be happy to answer any questions relating to the report.

The first general topic I would like to discuss is the research for the establishment and revision of National Ambient Air Quality Standards and National Emission Standards for Hazardous Air Pollutants. I will address three subjects under this topic: The process for establishing and revising national ambient air quality standards; hazardous emission standards; and the conduct of EPA's health effects research.

With respect to the National Ambient S[illegible]ndards, the Commission found that while the process for establishing and revising these standards has improved substantially since 1977, there are two portions of this process where additional research activities can significantly improve the standard-setting process.

First, the experience with the now famous DeLucia Adams study during the revision of the ambient air quality standard for ozone indicates that in the course of the preparation of a criteria document as required by section 108 of the act, it may be necessary for EPA to verify the results of tests conducted by others that are either controversial or ambiguous, but have a potential significance for regulatory decisionmaking. Recently during the revision of the nitrogen dioxide ambient standard, EPA was able to repeat the essential features of controversial studies under vigorously controlled conditions which led to unambiguous results.

Therefore, the Commission recommended that EPA continue to repeat essential features of chemical or toxicological studies that have not been replicated if the results are very important to the process and if EPA can repeat the study and analyze it within 1 year.

The second area of the standard-setting and review process where further research is needed involves risk assessment. The use of this tool encourages formal and vigorous analysis of the issues involved with a particular pollutant. Quantitative risk assessment involves predicting the probability that an adverse event will occur in a population over a period of time. Quantitative risk assessment is complex, speculative, and involves a number of uncertainties. These include predicting adverse effects at low doses, extrapolating from data obtained in animal studies to human risk, and accounting for different responses expected from different people.

EPA has begun to use risk assessment in its revision of the existing national ambient air quality standards. Its first attempt at the use of this process was severely criticized by both EPA's Science Advisory Board and industry. In light of the potential utility of this technique for establishing and revising national ambient air quality standards, the Commission recommended that EPA continue to refine the methodology of risk assessment for use in the standard-setting process.

The Commission's major finding regarding research for hazardous air pollutants is that there are significant and inherent limits to the scientific evidence on the precise effects of low doses of hazardous air pollutants at intermittent intervals, since these effects are likely to appear only after a long latency period. For cancer-causing substances, it is scientifically impossible to determine a level below which no effects occur. Based upon this finding, the Commission recommended that EPA should undertake an accelerated and continuing research program to identify additional air pollutants beyond those currenty under assessment which need additional study in order to determine whether they are hazardous air pollutants.

The Commission made a series of findings and recommendations regarding the conduct of EPA's health effects research activities.

Long-term, anticipatory, and basic research including epidemiology and lifetime animal studies are vital to the understanding and control of regulated and unregulated pollutants. The Commission found that EPA's research program, responding to immediate and sudden regulatory needs, favors short-term research at the expense of long-term, anticipatory, and basic research. The mandate in the Enviornmental Research, Development, and Demonstration Act of 1978 that 15 percent of all research funds at EPA be assigned for long-term work has not appreciably accelerated the development of strategies for long-term, anticipatory, and basic research. I believe that it is important for the incoming administration at EPA to make long-term research a priority item in its research budget.

Environmental emergencies such as Love Canal, Three Mile Island, and Mount St. Helens have required major shifts in the allocation of personnel and funds, disrupting other research conducted at EPA laboratories. Funds diverted from planned and ongoing programs often cannot be recovered, so the diversions can cause the interruption and in some cases the cancellation of research activities designed to support regulatory requirements. To remedy this situation, the Commission recommended that EPA should be appropriated a fund, separate from its regular research budget, to be used solely for research on environmental emergencies. New appropriations should be made as needed to sustain the fund at an adequate level.

Essentially what we are talking about is a revolving fund for which there would be annual appropriations. We recognize the difficulty of the appropriation process for long-term projects but we believe that some mechanism should be found to assure that once programs begin, that they are carried out to the maximum extent possible.

With respect to the actual performance of EPA's health research, the Commission found that improvements have been made over the last several years. The primary reasons for these improvements are, first, the use of formal, in-house research committees to help establish EPA's internal research priorities; second, by instituting peer review for all external research; and third, by shifting epidemiological research to external programs. EPA, as you may be aware, is rather gun-shy of long-term, epidemiological research after what occurred with the CHESS studies in the early to mid-1970's.

However the Commission found there is still room for significant improvement in EPA's in-house research activities. Two ways in which the program can be improved are: First, peer review for internal research—at the present time, there is no peer review for internal research—and second, short-term use of outside experts who have expertise that the agency staff may not be able to have in certain areas. We believe, with these improvements, the internal program at EPA should be improved significantly.

As the committee may be aware, past deficiencies in major research programs, particularly in epidemiology have called into question EPA's ability to conduct scientifically credible research and to retain scientists of high caliber. Such criticisms have prompted suggestions that EPA's research functions be assigned to some other organization.

However, the Commission recommended that EPA should retain its current research and regulatory functions, but should bolster reliance on independent peer review of all health effects research. The Commission believed that separation of the research and regulatory functions such as that found with the Occupational Safety and Health Administration and the National Institute of Occupational Safety and Health has not enhanced the overall functional capability of OSHA and has not led to research which is truly supportive of this agency's function. One of the subsequent witnesses, Dr. Robert Frank, who was on the Commission staff, I think can testify extensively about some of the concerns, some of the problems that OSHA has faced because of this split between the regulatory function and the research function being in separate departments of the Government.

The second major topic I would like to discuss is research for air quality monitoring and measurement. Before discussing the Commission's findings regarding this topic, I believe that leadership by EPA in both of these areas is necessary if long-term improvements are to be made. As a general rule, State and local governments simply do not have the resources to apply to these matters. Furthermore, it is important that there be consistent ambient monitoring throughout the Nation and consistent measurement techniques for source categories. One could imagine the problem if 50 separate States decided to have different measurements for the some pollutant. The difficulties in enforcing a program of that sort would be very apparent. In my view, this type of technical guidance must come from the Federal level if States are to effectively carry out the act.

With respect to ambient air quality monitoring, the Commission found that the quality of existing air monitoring data varies substantially from area to area. The primary reasons for this variance are the lack of guidance from EPA in the past; and inadequate State and local resources being put into this matter.

However a Commission study concluded that by 1983 air quality monitoring data for urbanized areas will be adequate if State and local control agencies maintain the recently expanded levels of resources and personnel devoted to monitoring and fully implement EPA's recent monitoring regulations which provide a consistent national approach to data handling and monitoring equipment. It is important to point out that the Commission study of air quality monitoring found that contrary to what happens in many situations with EPA regulations, that here there was very strong support by State and local governments for the regulations that EPA developed. Again, the thrust of these regulations was to try to make air quality monitoring consistent throughout the United States and to upgrade the air quality systems so that we can get a better handle on what the air quality is in many of our urban areas.

The Commission found that monitoring and surveillance techniques now used by air pollution control agencies to determine compliance with applicable requirements have two major shortcomings. First, these techniques do not address all pollutants. Since the most widely used technique for determining source compliance today continues to be visual emission readings and visual inspections or opacity checks; emissions of invisible pollutants such as hydrocarbons cannot be identified through the use of these techniques.

Second, the air control programs do not provide for routine surveillance of all sources. The use of continuous stack monitoring or fuel sampling could help eliminate this shortcoming, but more research and development is needed to make accurate and reliable continuous monitoring available at reasonable costs. Right now, at least for some categories of sources, continuous monitoring is not what it should be, and some Commission studies found that this is an area where there should be significant additional research.

However, even if continuous monitoring is applied to emissions from stacks, it will still be difficult to accurately measure fugitive emissions from sources. One can imagine a chemical complex where there are literally thousands of valves and flanges which are subject to potential leaks, seal deterioriation, or something like that and could be a major source of emissions; even with the use of continuous monitoring it would be extremely difficult to determine whether in fact the facility was operating properly.

Due to the shortcomings found in the measurement of emissions, the Commission recommended that EPA should augment its current efforts to encourage continuous compliance by stationary sources. In the short term, EPA should conduct the research necessary to give State and local control agencies enough information to help them establish source-specific operating standards and should develop programs to provide guidance for States in applying these standards. Over the longer term, EPA should encourage or require States to increase their use of continuous emission monitors and systematic use of the act's current reporting and data collection requirements.

The third major topic I would like to discuss is research for air pollution control devices. At the outset I would like to state that in my opinion EPA should not conduct research for control equipment or processes except in cases such as an emerging industry for example, synthetic fuels—or for particularly difficult problems which cut across several industries for example, control of oxide or nitrogen emissions from stationary sources.

Due to time constraints, I will summarize the recommendations in this area. First, there is continuing need for research and development for new technology and processes to compensate for emissions from new and expanding sources and to control potentially hazardous pollutants.

Second, a major disincentive to research and development of inherently low-polluting emission processes is the Internal Revenue Code. The Code favors the use of add-on controls rather than process changes that are inherently low polluting. The example that we used in the Commission's report was the example of end-of-pipe sulfur dioxide scrubbers versus fluidized bed combustion. The IRS Code provides rapid writeoffs and in some instances for favorable non-tax bonding for pollution control equipment such as the scrubber—but yet a facility which uses an inherently clean process may not be eligible for either of these kinds of tax writeoffs. I believe we may be missing a great opportunity to control emissions in a much more rational way by the current policy that is included in the Internal Revenue Code.

The final topic that I would discuss is research for emerging issues such as long-distance transport, carbon dioxide, and indoor air pollution. It is now widely accepted that some types of air pollution disperse from the emission source and travel in the atmosphere for distances of up to 1,000 kilometers. Increasing interstate flow of air pollution, transport of ozone and ozone precursors, acid deposition, including acid rain and dry deposition of acid, and reduced visibility are problems largely associated with long-distance transport.

Acid deposition and visibility impairment are complex, large-scale phenomena that are not well understood. Although a direct link between reductions in emissions of sulfur dioxide and oxides of nitrogen, reductions in adverse regional air quality impacts cannot be precisely determined, reductions both in the amount of sulfur dioxide and oxides of nitrogen and in the amounts of compounds that enhance the transformation of these substances in the atmosphere is expected—and I emphasize "is expected"—to result in a lessening of acid deposition and improvement in visibility and a reduction in levels of fine particulate matter.

The reason I emphasize the "is expected" is because it is not a matter, I believe, of absolute scientific certainty, but at least the evidence that was provided to the Commission indicated that certainly to the extent that these emissions could be reduced, there would be some improvement expected.

As I am sure the committee is aware, long-range transport of air pollutants, particularly pollutants contributing to acid deposition, has become an international concern. The Canadian Government regards acid deposition as its most critical environmental problem, and the United States and Canada have formed bilateral research groups to investigate the transboundary long-range pollutant problem. This issue was brought home to me when about 6 weeks ago I had the opportunity to travel to Montreal to speak to a conference put on by the Air Pollution Control Association in Ontario and Quebec, and the feeling of the people in Canada over the question of acid rain is quite strong and runs quite deeply.

Based on the Commission's findings, the Commission recommended that Congress should appropriate adequate funds to enable the appropriate executive agencies to carry out acid precipitation research programs authorized by Congress. In particular, emphasis should be placed on the link between the reduction of emissions and reduction in acid deposition and increased visibility.

One area that is the most uncertain is the proposition that if we reduce emissions by a certain percentage that we are going to get an improvement. We need to really emphasize that kind of research, that kind of modeling, in the research program that is currently ongoing. That, I think, is something that has not received, in my view at least, the proper emphasis up to this time.

In addition, Congress should provide funding and direct the appropriate Federal agencies from among those participating in the task force on acid deposition to develop long term, nationwide atmospheric acid deposition monitoring programs to assess by geographic region long-term trends in dry and wet deposition and the effects of the deposition on water and land.

Increased carbon dioxide in the atmosphere, resulting primarily from the combustion of fossil fuels, has the potential for causing significant changes to global climate in the next century due to warming of the lower atmosphere. This is commonly known as the greenhouse effect. Changes to global climate could include changes in temperature, cloud formation, precipitation, wind patterns, resulting in changes in the distribution of arable land and in the distribution, composition, and productivity of natural ecosystems.

Carbon dioxide can remain in the atmosphere for several hundred years. Consequently most current emissions of carbon dioxide can remain in the atmosphere through the 21st century.

There is substantial debate in the scientific community over the time at which carbon dioxide increases or the "greenhouse effect" will have adverse effects. There are some who claim that the time will be as rapid as the year 2020. There are others who argue that we must wait and see what the effect of absorption of carbon dioxide by the oceans and other natural sinks for carbon dioxide is before we can draw any conclusions, and they would stretch the time out probably toward the end of the next century.

But I think most people agree that unchecked, this is a matter of some consequence. And again, I think that most people agree that this is a matter that the United States itself cannot solve. It will take international efforts to resolve the problem.

The Commission recommended consideration of support for research in the United States to address scientific uncertainties associated with carbon dioxide sources, dispersal, climate modeling, and the effects of climatic change. Scientific research should be augmented by studies of policy options for addressing problems associated with increased carbon dioxide levels, including mechanisms and plans for implementation.

In addition, expanded international scientific and public policy research should be undertaken, possibly under the auspices of an International Carbon Dioxide Assessment Board established through existing international organizations.

The final topic I would like to discuss this morning is indoor air pollution. Indoor concentrations for some of the criteria air pollutants appear to be substantially higher than concentrations allowed under current air quality standards in the ambient air—that is, the outdoor environment. In particular, carbon monoxide, nitrogen oxides, and particulate matter are emitted into the indoor environment, and in some cases indoor concentrations of known or suspected carcinogens, such as formaldehyde, are considerably higher than the outdoor concentrations.

Tobacco smoke is a significant source of indoor fine particulate matter and other pollutants. Reliance on increased use of building insulation and mechanical ventilation to conserve energy can reduce the indoor/outdoor exchange of air, resulting in increased build-up of indoor air pollutant concentrations.

The Commission recommended that Congress should direct several Federal agencies to identify the resources necessary to undertake a systematic and coordinated program to improve air quality monitoring in the indoor situations and to refine estimates of the relative public health risk caused by indoor exposures to pollutants currently regulated under the act and which may be regulated in the future.

Agencies with jurisidiction over environmental protection, product safety, energy conservation, public health and housing authorities should participate in this interagency program.

I hope that this overview of the National Commission on Air Quality's findings and recommendations regarding air pollution research will be useful to these subcommittees for future deliberations. At the conclusion of the other speakers' remarks, I would be happy to answer any questions you may have on research or other portions of the Commission's report.

Thank you.

Mr. YOUNG. Thank you, Mr. Penna.

We will now proceed to Mr. David Swan. Mr. Swan, your statement will be made a part of the record.

Mr. SWAN. Thank you, Mr. Chairman.

Rather than direct my remarks to a series of specific problems related to the Clean Air Act, I would like to discuss two of the broad scientific and technical issues which many people in the business community think need to be addressed by Congress during the debate on reauthorization of the act.

These issues are: First, how can we assure the integrity and quality of the scientific and technical data base used as the basis for regulation?

Second, how can we get the benefits that we seek from improved environmental quality, without sacrificing productivity losses and innovation gains in the process of doing it?

I will comment on both of these issues, which I think among the most important ones facing the interaction of the Clean Air Act with our American society.

First, to deal with the scientific data base, I think one of the things that is often lost sight of is that environmental regulatory decisionmaking involves two different kinds of judgments: First, a technical judgment must be made which should be based on the most valid scientific information and analysis available.

The second step of the process is a political judgment which is based on striking a balance among competing policy considerations, and which, of course, results in things like numerical standards which, in and of themselves, do not completely describe a complex situation, but which are an attempt to put a number that everybody can understand, that we can all live with—like a 55-mile-per-hour speed limit. Failure to recognize the need for this two-step process has led to a great deal of controversy and needless conflict in our programs to protect and enhance the quality of the environment.

My remarks today are directed to the quality of the scientific data on which the EPA Administrator must rely in setting standards and other implementing regulations.

To put it bluntly, EPA has relied on erroneous or flawed data in formulating policies, setting standards, and preparing regulations, frequently enough to cause concern about its basic scientific quality control procedures.

I think this is supported by some of the findings of the National Air Quality Commission. Concern about this has also been expressed by a number of objective reviewers, including the National Academy of Sciences, EPA's own Science Advisory Board, the National Commission itself and, in the past, this committee.

I will not bore you with a recitation of examples, although I would be glad to give them for the record, if you so desire.

However, I would like to quote from a letter to EPA Administrator Costle, signed by Dr. Cantlon, Chairman of EPA's Science Advisory Board Executive Committee, who pointed out last year that:

> When the quality of the science that is used is poor, decisions can be strongly contested by the regulated. Furthermore, poor science erodes both credibility of the agency and the public's confidence in scientists. In some circumstances, poor science can lead to needless human fear and suffering.

This last is a very important consideration because, if the general public is persuaded, through the use of the erroneous data, that they are threatened with some life or health threatening pollutant, it can lead to all kinds of emotional action, as we all know.

I will mention only one other example, originated by this committee.

In its review of the CHESS report, this committee noted—and I quote: "Political and temporal pressures often weakened the credibility of scientific data which supports EPA's regulatory program." That was a report from the 1977 session of the 95th Congress.

Congress itself has recognized the need for an independent scientific review committee, by creating in the 1977 amendments to the Clean Air Act, the Clean Air Science Advisory Committee, which is usually known by the acronym CASAC, which was supposed to have two major functions.

First, the committee was directed to review air quality criteria documents which, as you all know, are the compendium of scientific information which the Administrator must rely on in setting national ambient air quality standards. They were also asked to review the standards themselves. They were empowered to recommend new national air quality standards, and recommend revisions of criteria documents and standards, as may be appropriate.

Now, in addition—and this is quite important—the committee's second and no less important responsibility under the act is to advise the EPA Administrator in five areas, including adverse public health, welfare, social, economic, and energy effects which may result from different strategies to meet the national ambient air quality standards.

In other words, the committee was intended to act as a representative group which would consider both the scientific data which underlay the standards, to comment on the standards themselves, and to consider the control strategies devised to meet them thus involving them in both stages of the process which I previously described.

Contrary to this expressed congressional intent, EPA has chosen to limit CASAC's participation in the standard-setting process to reviewing criteria documents, period. It has organizationally placed CASAC as a subcommittee of its Science Advisory Board.

The Clean Air Science Advisory Committee itself has been quite restless in this limited role, and is now in the process of developing recommendations to the new Administrator, to expand the CASAC role within the Agency, to be more consistent with the congressional intent, as expressed in the clean air amendments.

The business community in general strongly supports both EPA and congressional efforts to improve the quality of the scientific data base which is used to support regulations. Many business organizations have expressed themselves on this issue.

I would like to give you the Business Roundtable position, which recommends:

First, that mandatory procedures should be established for scientific evaluation of data from studies, so that only valid information is used in any standard-setting process. Further, these procedures should require an evaluation of the significance of individual studies.

Second, Congress should require the Administrator of EPA to consider explicitly the recommendations and advice of an independent science advisory committee throughout the NAAQS-adoption process.

There is a wide consensus in the scientific community itself that acceptable criteria for the inclusion or exclusion of research results in criteria documents must be developed and agreed on by all concerned, and that adequate peer review must be assured. And this is particularly important when the standard relies on such scientific techniques as epidemiological studies which in and of themselves involve the statistical manipulation of data.

Only by a rigorous quality assurance effort can we avoid accepting unproved hypotheses as scientific fact. This quality assurance, should be carried out and managed by qualified members of the scientific community. This is extremely important.

In the final analysis, responsibility for the integrity of science rests with the entire scientific community. If this integrity is violated consistently, public respect for the community will decline, as was pointed out by Dr. Cantlon.

Now, in addition to the quality control function, which I have emphasized and for which improvements are vitally necessary scientists can also play a significant, but not dominant, role in the actual decisionmaking process—the second part of this two-stage process I described.

As you know, this involves the Administrator selecting from many options, appropriate numerical standards and regulations.

Of particular importance, and where the scientific community can help, is the need to increase the number of tools and techniques available to assist the Administrator in these decisionmaking responsibilities.

For example, one such technique, which has not yet been widely adopted by EPA, is the use of risk analysis and assessment.

Risk analysis, in and of itself, does not prescribe or recommend any particular course of action, but simply provides a logical basis for choosing options for final decisionmaking. It does not involve research. The technique itself may involve research in formulating its use, but the analytical process itself makes use of existing data, and relies on existing knowledge. Its application recognizes that the various steps of the decision process must be kept separate, if defensible decisions are to be made.

These steps, of course, involve the collection of data—and, I should add, its validation—assessing the impacts of the subject of concern, and finally putting all of this together and making the regulatory decision.

Sadly, there have been enough instances where political and regulatory considerations have overridden the logical and orderly development of standards that direct attention by the Congress is necessary.

I would like to leave this general discussion of the quality and credibility of the scientific data base, and talk about another impact of regulations in general.

That is the impact of the regulatory process on innovation.

To develop this notion, I would like to point out, as I am sure you all know, that the current economic theory—notably articulated by the late Joseph Shumpeter of Harvard University, postulated that technical innovation is the principal, and perhaps only, source of economic growth in industrial societies.

There has been a lot of research to prove a disprove this hypothesis A considerable body of literature has appeared in support of this hypothesis, and no other credible theory has been advanced that successfully accounts for the increases in productivity that have been experienced in the Western, and now the Far Eastern, industrialized countries.

As we all know, productivity in the United States has recently declined, both in the absolute sense and more alarmingly from our point of view, relative to our principal industrial competitors in Japan and Western Europe.

A number of scholars have attempted to identify the effects of Government regulation on this slowdown, and to prove or disprove the hypothesis that regulation, in and of itself, affects the process of innovation.

Among these are Mr. Weidenbaum of the new administration's Council of Economic Advisers; Dr. Denison, who has been with the Brooking Institute and the Department of Commerce; in addition, EPA and the Council on Environmental Quality have commissioned consultant studies to try to determine economic effects of environmental regulations on such indicators as inflation rates and predictions of the gross national product.

The important observation here is that while the studies differ widely in their estimate of the magnitude of the effects of regulation, they are in agreement that regulatory impacts are negative.

For example, CEQ argues that ~~inflation was~~ only mildly affected—or GNP would have grown perhaps 0.5 percent more rapidly sans regulation. Whereas Weidenbaum argues that regulation shows a much larger adverse effect.

But nobody shows a positive effect of regulation on economic growth.

In addition to the macroeconomic studies that I have mentioned, there have been a number of studies on specific segments of the U.S. industrial sector. And of course, as we all know, the effect of regulation is to increase operating costs and requirements for capital for the regulated industry.

Another of the important distinctions that can only be picked up in microeconomic studies is that the impact of environmental regulations varies widely on specific industrial segments. As you might expect, the service industries tend to have minimal detectable environmental costs.

Fabricating industries, which comprise the bulk of U.S. manufacturing, tend to require somewhere around 7 to 10 percent of their capital, and approximately of the same amount, in terms of operating costs to meet environmental regulations.

But the basic industries have environmental capital redemption ranging as high as 30 to 50 percent. Now, these particular industries which are most heavily impacted—and I'd like to identify them by name—are the: electric utility industry; copper, lead, and zinc; steel; chemical products; pulp and paper; and petroleum refining.

This is not an unexpected result, because these are the industries where the basic residuals from natural materials are separated and must be discarded.

However, you can, by examining this set of industries, uncover some of their common characteristics:

They are basic in that they deal with the conversion of raw materials which serve as the precursors to manufactured products.

They are capital intensive. That is, the investment required per unit of output, per dollar of sales, tends to be very high compared with the average of all industries. For example, in mining, it is of the order of $2 to $3 per annual dollar of sales.

In addition, they are usually capital extensive. That is, in order to secure the economies of scale, the individual facilities and the investment that goes with them tend to be extremely large. Typical projects run of the order—in mining, for instance—of $1 billion per project, or more.

And with the exception of electric utilities, all of the basic industries must compete in the international marketplace. Therefore, the impact of any U.S. policies must be viewed in an international context, if we are not to unwittingly cause some damage to regulated industry, and to U.S. national interests.

I would like to contrast these characteristics with my perception of current U.S. environmental policies, as embodied in the Clean Air Act. If you examine the legislation and regulations to implement it, you can uncover some general principles which are being followed:

First, the U.S. de facto policy relies on emission reduction as the principal control strategy. And one might argue that the ultimate goal, of course, is zero emissions. And if one broadens this and looks at the entire environmental framework of law and regulation, what we appear to be striving for is no discharges into air and water, and the collection of the residual solid wastes in an inert form which is storable indefinitely.

Now, I think all of the legislation recognizes that this is a goal, and not to be accomplished tomorrow. But, generally speaking, the policy can be expressed as that.

Of course, one example of where we really seek to achieve this goal is in the disposal of nuclear waste, whose hazards justify extreme precaution.

A second principle which is followed is that specific timetables for the achievement of predetermined emission reduction goals have been set, both by Congress and by regulation; and thereby, these goals receive a higher priority than other competing national goals which do not have a time certain for attainment.

Third, the regulations which EPA provides for enforcement of the existing law generally include detailed operating specifications, as well as performance requirements for achievement of the goals, with the result that cost-effective solutions to environmental cleanup are often ignored.

That is, when a requirement is set for emission reduction at a certain level, this ignores whether that level is the most cost-effective way of dealing with the problem of environmental cleanup.

Fourth, the United States as adopted a polluter-pays policy, which places the primary economic burden for emission reduction on the operator of the source, although in some cases Congress has provided for alleviation of this, through special tax treatment or other offsets, which has been discussed by Mr. Penna.

Now, singularly, any one of these principles might not be a particularly onerous burden; but collectively, taken together, these principles impose a complex and quite inflexible set of constraints, primarily on the U.S. private, nonresidential, manufacturing sector.

As a result, a number of things have happened which I am certain were not intended by the proponents of the legislation.

Specifically, as I pointed out earlier, reliance on emission reduction requires that waste residuals be captured and transformed into some inert form. Now, preferably, one would like to use this inert form as an intermediate product which can be recycled as part of an industrial process.

However, this is not always recognized because of the complexity of the laws.

For example, in mining wastes, our current processes are just simply not good enough to recover all of the mineral values; and we do have wastes such as tailings or waste piles which contain minerals. And throughout history, as new technology has been developed, the mining industry has been able to utilize what was formerly discarded as waste.

This notion is currently under attack in several proposed regulations, which propose to treat mineral-bearing residuals as waste, to be covered up and disposed of permanently, to be achieved by time certain.

This, I would submit, would be a non-cost-effective way of dealing with the problem.

What happens, as a generality, is when you are faced with a specific time constraint, you have to rely on a presently available technology, which leads to the end-of-pipe treatment approach of dealing with pollution control or emission reduction.

With particular reference to the basic industries, characterized by high-fixed investment, very often one cannot afford to scrap an entire investment in order to install a new process, so that the economic forces leading to end-of-pipe treatment are multiplied in the basic industry. When added to the time constraints already mentioned, I would submit that rather than achieving a result of forcing new technology, as some of the proponents of the Clean Air Act asserted, this approach, in fact, is technology freezing.

In addition, the imposition of operating specifications also inhibits the development of radically different and improved technologies, particularly when coupled with the time constraint. The polluter-pays policy, coupled with fixed time constraints, creates unequal economic burdens on the different industry sectors, and I might add on different geographic sectors as well.

If the industry is prevented, as most of our basic industries are, by international competition from passing through its additional cost to its customers, further investment in production facilities has to be curtailed and, of course, in its worst case, this will lead to the demise of the U.S. facilities, and domestic markets will have to be served by offshore suppliers. This, in fact, is happening. It has been documented by the General Accounting Office in a number of excellent reports, and it appears to be happening certainly in my own industry in the copper smelting sector.

I am sure you have heard of the recent shutdown of one of the major smelters in this country and the consequent export of American copper concentrates to Japanese sources for reprocessing.

In addition to the impacts of the policies themselves, unnecessary delays introduced by the lengthy permitting procedures result in severe investment constraints. One of the things which is ignored in the Clean Air Act and by EPA and its regulations, is the concept of the time value of money which is central to investment planning and decisionmaking, particularly with respect to new markets and technology. Given the current discount rates which must be used in calculating the present worth of a future revenue stream, the present value of a typical new product would be halved by a 3-year delay, and a 3-year time delay in permitting is by no means uncommon, particularly in the basic industries.

These calculations, even though they may not accurately forecast the future, can have a chilling effect on corporate support of innovation and on the allocation of corporate R. & D. resources. If there is a long timelag envisaged in bringing a new project to fruition, shorter payout projects are sought, particularly when alternate opportunities exist in areas where regulation is less.

I think one of the underlying reasons for the slowdown in productivity and its precursor slowdown in innovation in the more basic industries is the concern that the investment in the R. & D. necessary will never be recovered, at least by the American investors. Clearly, the process of regulation must be improved if we are to overcome these inherent inhibiting effects on productivity, and I hope this committee will assist in recognizing some of these facts in making recommendations for both improving the use of science and removing some of the impediments to innovation which exist in the Clean Air Act as currently written and interpreted.

I would be glad to answer any questions at an appropriate time. Thank you very much.

[The prepared statement of Mr. Swan follows:]

TESTIMONY OF DAVID SWAN
VICE PRESIDENT FOR ENVIRONMENTAL ISSUES
KENNECOTT CORPORATION

BEFORE THE HOUSE SCIENCE COMMITTEE
SUBCOMMITTEE'S ON NATURAL RESOURCES AND ENERGY DEVELOPMENT

May 19, 1981

Mr. Chairman, and members of the Committee, my name is David Swan, and I am Vice President, Environmental Issues for Kennecott Corporation. In addition to my corporate responsibilities, I also serve on the Staff Services Subcommittee of the Environmental Task Force of the Business Roundtable, and Environmental Matters Committee of the American Mining Congress. Prior to my present assignment, I participated in and directed Research and Development for a period of 35 years with Union Carbide and with Kennecott. I also served as Chairman of the Environmental Regulatory Panel on the Industrial Advisory Committee on Industrial Innovation, established as part of the prior Administration's domestic policy review on industrial innovation.

Rather than address my remarks to a series of specific problems related to the Clean Air Act, I would like to discuss two of the principal broad scientific and technical issues which need to be addressed by the Congress in its reauthorization of the Clean Air Act. These issues are: (1) how can the integrity and quality of scientific and technical data used as the basis of regulation be ensured, and (2) how can the adverse effects of environmental regulations on innovation be lessened without significantly sacrificing attainment of the Nation's environmental goals.

Environmental regulatory decision-making necessarily involves two different kinds of judgments; the first a technical judgment which should be based on the most valid scientific information and analysis; the second, a political judgment based on striking a balance among competing national policy considerations. Failure to recognize the need for this two-step decision-making process has led to a great deal of controversy and needless conflict in the Nation's programs to protect and enhance the quality of our environment.

My remarks today are directed to the quality of the scientific data upon which the EPA Administrator must rely in setting standards and other CAA implementing regulations. To put it bluntly, EPA has relied on erroneous or flawed data in formulating policies, setting standards, and preparing regulations frequently enough to cause concern about its basic scientific quality control procedures. Concern about this has been expressed by a number of objective reviewers, including the National Academy of Sciences, EPA's own Science Advisory Board, the National Commission on Air Quality, and this Committee.

Dr. Cantlon, Chairman of the Science Advisory Board Executive Committee, in a letter to the EPA Administrator last year stated "when the quality of the science that is used is poor, decisions can be strongly contested by the regulated. Furthermore, poor science erodes both credibility of the agency (and) the public's confidence in scientists. In some circumstances, poor science can lead to needless human fear and suffering." (Letter, July 22, 1980.)

In its review of the CHESS report (Health Consequences of Sulfur Oxides) this Committee noted that "political and temporal pressures often weakened the credibility of scientific data which supports EPA's regulatory program." H.R. Report 157, 95th Congress - 1st Session 38 (1977).

Congress itself has recognized the need for an independent scientific review committee by creating in the 1977 Amendments to the Clean Air Act, the Clear Air Science Advisory Committee (CASAC) with two major functions. First, the committee should review air quality criteria documents, primary and secondary national ambient air quality standards (NAAQS), and recommend new NAAQS and revisions of these criteria documents and standards as may be appropriate. (Sec. 109 (d) (2) (B).) The Committee's second and no less important responsibility is to advise the EPA Administrator in four areas including "adverse public health, welfare, social, economic and energy effects" which may result from different strategies to meet NAAQS.

Contrary to this expressed Congressional intent, EPA has chosen to limit CASAC's participation in the standard setting process to reviewing criteria documents and has organizationally placed CASAC as a subcommittee of the Science Advisory Board. CASAC itself has been restive in this limited role and is developing recommendations to the EPA Administrator to expand their role with the Agency to be more consistent with Congressional intent.

The business community strongly supports both EPA and Congressional efforts to improve the quality of the scientific data base which is used to support standards and regulations. The Business Roundtable, for example recommends that:

1. Mandatory procedures should be established for scientific evaluation of data from studies so that only valid information is used in any standard-setting process. Further, these procedures should require an evaluation of the significance of individual studies.
2. Congress should require the Administrator of EPA to consider explicitly the recommendations and advice of an independent science advisory committee throughout the NAAQS-adoption process.

There is a wide consensus in the scientific community that acceptable criteria for the inclusion or exclusion of research results in criteria documents must be developed and agreed on by all concerned, and that adequate peer review must be assured. Only by a rigorous quality assurance effort can we avoid accepting unproven hypotheses as scientific fact. This quality assurance should be carried out and managed by members of the scientific community.

In the final analysis, responsibility for the integrity of science rests with the entire scientific community. If this integrity is violated, public respect for the community will decline.

Scientists can also play a significant, but not dominant role in the actual regulatory decision-making process, which involves selecting from among several options appropriate numerical standards and regulations. Of particular importance is the need to increase the tools and techniques available to assist the Administrator in his decision responsibilities. One such tool is risk analysis and assessment.

The assessment itself does not prescribe or recommend any particular course of action, but provides a logical basis for options for final decision-making. Risk analysis does not involve research, but relies on existing knowledge, and its application recognizes that the various steps of the decision process should be kept separate if defensible decisions are to be made -- these steps involve collection of data, assessing impacts and final decision-making. Sadly, there have been enough instances where political and regulatory considerations have overridden the logical and orderly development of standards for direct attention by the Congress.

The second broad issue I would like to discuss with you today has to do with the impact of the Clean Air Act on Technological Innovation. As I need not remind this Committee, the late Joseph Shumpeter developed the notion that technical innovation is the principal, and perhaps only, source of economic growth in the industrial societies. A considerable body of economic literature has appeared in support of this hypothesis, and no other credible theory has been advanced that successfully accounts for the increases in productivity that have been experienced in the western (and now Asiatic) industrial countries. Unfortunately, productivity in the U.S. has recently declined, both in the absolute sense and even more alarmingly, relative to our principal industrial competitors. A number of scholars have attempted to identify the effects of governmental regulation on this slowdown, among them Weidenbaum and Denison. EPA and the Council on Environmental Quality have also commissioned consultant studies to predict economic effects on such indicators as inflation and GNP. Almost all the studies show some net adverse effect, but vary widely in estimates of magnitude.

In addition to the macro-economic studies mentioned above, a number of studies have been carried out on specific segments of the U.S. industrial sector. Adverse capital and operating cost impacts of environmental regulations on specific industrial segments show a wide range -- service industries tend to be very low; fabricating industries divert some 7 percent of capital to environment control; and the basic industries have environmental capital pre-emption ranging from 30 percent to 50 percent. The six most heavily impacted industries are: electric utilities; copper, lead and zinc; steel; chemical products, pulp and paper; and petroleum refining.

The most severely impacted industries share a series of common characteristics.

1. They are basic in that they deal with conversion of raw materials to intermediate products, which are in turn used in manufactured products.

2. They are capital intensive, that is, the fixed investment required per dollar of sales is high.
3. They are capital extensive, that is, in order to secure economies of scale, individual facilities tend to be very large.
4. With the exception of electric utilities, all must compete in an international marketplace, therefore the impact of U.S. policies must be viewed in an international context.

Current U.S. environmental policies, as embodied in the Clear Air Act follow these general principles.

1. Reliance on emission reduction as the principal control strategy, with the ultimate goal of zero emissions.
2. Specific timetables for the achievement of predetermined emission reduction goals, with environmental clean-up given a higher priority than other competing national goals.
3. Detailed operating specifications, as well as performance requirements for achievement of specific emission goals, with the result that cost-effective solutions to environmental clean-up are often ignored.
4. Placement of the primary economic burden for emission reduction on the operator of the source (the "polluter pays" policy).

Collectively, those principles impose a complex and inflexible set of constraints on the U.S. private non-residential manufacturing sector. Certain results have occurred which were not intended by the proponents of the legislation. Specifically:

1. Reliance on emission reduction requires that waste residuals be captured and transformed into an inert form for indefinite storage, or preferably reused as an intermediate product which can be recycled in an industrial process. When this requirement is imposed under a specific time constraint, it forces reliance on presently available technology and end-of-pipe treatment -- particularly when the requirement is placed on industries with high fixed investments already in place which cannot be scraped. This results in "technology freezing", rather than "technology forcing", as was intended.
2. Imposition of operating specifications plus performance requirements inhibits development of radically different improved process technology. Furthermore, since no two facilities are the same, generic regulations often lead to inconsistent results and effects.
3. The "polluter pays" policy, coupled with fixed time constraints creates unequal economic burdens on different industry sectors. If the industry affected is constrainted by international competition from passing onto its customers further investment in

> production facilities. In its worst case, this will lead to the demise of the U.S. facilities and domestic market will be served by offshore suppliers.

In addition to the impacts of present policies, unnecessary delays introduced by lengthy permitting procedures result in severe investment constraints. Time is central to investment planning and decision-making for innovative markets and technology. The concept of time value of money has been ignored in the Clean Air Act and by EPA. For example, at current reasonable discount (or interest) rates, the present value of a typical product will be halved in three years. Such calculations can have a chilling effect on corporate innovations in both products and processes, particularly when alternate opportunities exist in areas where regulation is less.

Clearly the process of regulation must be improved, if we are to overcome its inherent inhibiting effects on productivity.

I hope that this Committee will assist in making recommendations for improving the use of science under the Clean Air Act, and will help to remove the current impediments in the Clean Air Act which hinder innovation, modernization, and productivity.

I would now be happy to answer any questions that the Committee may have.

Mr. **SCHEUER**. Thank you.

And now we will hear from Dr. Oppenheimer of the Environmental Defense Fund.

Dr. **OPPENHEIMER**. Mr. Chairman, I would like to thank the committee for giving me this opportunity to testify today. I am a senior scientist in the New York office of the Environmental Defense Fund, a national nonprofit organization. Previous to that I was an atmospheric scientist at the Harvard-Smithsonian Center for Astrophysics at Harvard University in Cambridge.

I am currently involved in various aspects of research in air quality and long-range transport of air pollutants, and particularly the acid rain problem. I recently participated in a workshop held by the Interagency Task Force on Acid Precipitation to evaluate the national acid precipitation assessment plan. My testimony today is on behalf of my own organization, but at the suggestion of the National Clean Air Coalition.

As a scientist, I am particularly pleased to have this opportunity to express my views to the committee on research efforts related to air quality, because this issue is of great personal interest to me. The perspective I will give you is one of a scientist who is attempting to use the fruits of basic research on air-related issues in order to formulate reasonable policy alternatives for dealing with air quality problems.

As a starting point for this testimony, I will briefly outline my own work and use it to illustrate the following assertion: that an adequate air quality program requires a significant commitment to support for basic research on the part of EPA. I am concerned that that commitment is disappearing, given the current concern with reducing the size of the Federal budget.

The support for basic research by EPA has declined by $4 million between 1980 and 1981, and I think further cuts are likely in the budget that is currently under consideration. These cuts will affect programs which are critical to defining and maintaining adequate air quality standards.

Let me give you an example from my present research interests which focus on long-range transport and acid rain. As you know, oxides of sulfur, largely produced by powerplants as well as oxides of nitrogen, are emitted into the atmosphere by tall stacks, and are carried away by the prevailing winds. They are transformed into nitrates and sulfates during this passage, and then deposited at great distances from their source as nitric acid, sulfuric acid, and as fine particle nitrates and sulfates. Essentially, the rain that comes down is a dilute solution of nitric and sulfuric acids.

Fine particles are not separately regulated as criteria pollutants under the Clean Air Act, but are part of the total suspended particulate, TSP, category, in spite of the fact that they are believed to be significantly more damaging to health than the larger particles which constitute the bulk of TSP.

For many years environmentalists have encouraged EPA to set criteria for fine particles, to no avail. EPA has consistently asserted that sufficient evidence for setting this standard does not exist. It is reasonable to ask at this point why, after 10 years, such scientific evidence still is not available. As an example, in the recent draft criteria document on SO_2 and particulate matter, the studies that were referred to with regard to both SO_2 and particulates were generally 10 years old, indicating that little useful research had been accomplished over the last decade.

Now, this matter would be of less concern to me if I thought an active research program was underway to aid in the setting of fine particle standards. However, recent events suggest that EPA is moving in the other direction.

Recently, it has been rumored that that epidemiological research may soon be eliminated as a discipline at EPA. Such an action should be of the gravest concern to this committee. Epidemiology is an absolutely critical component of any attempt to set criteria on an annual average basis for environmental pollutants.

As you know, there are short-term criteria and long-term criteria as well, under the Clean Air Act. For example, fine particle levels of 1,000 micrograms per cubic meter cause discomfort to humans in short-exposure clinical experiments where people are exposed for perhaps 15 minutes, while levels of 100 micrograms per cubic meter are relatively harmless for short exposures. On the other hand, some limited epidemiological evidence exists to suggest that levels of 10 to 20 micrograms per cubic meter, in other words, 100 times less than noticed in the laboratory, cause adverse health effects to children over long-term exposure. Clearly, such exposure levels are well below the thresholds for observable effects in clinical experiments.

I am aware that epidemiological experiments are difficult to perform in such a way as to obtain unambiguous information. On the other hand, alternative sources of information on response to low-levels of exposure over long periods of time provide only indirect information and are fraught with their own difficulties.

Picking up on a remark that Mr. Swan just made, I should note that all determinations of effects of particularly low level exposures are statistical in nature, and that that is not peculiar to epidemiology. A further problem is that nonepidemiological methods for determining effects of low-levels of exposure basically are unable to address the problem of synergistic effects of several pollutants acting at once, a significant problem in the Northeast.

The elimination of epidemiological research support by EPA will destroy a necessary component in the setting of criteria for long-term exposure to low doses of pollutants. The effect of such an action will be to prevent the setting of criteria for long-term exposure to low doses of pollutants. In other words, the result of this action will be to prevent the setting of annual average exposure standards for not only fine particles such as sulfates, but also a host of so-called toxic pollutants which are particularly dangerous to human health.

Only four such air pollutants, asbestos, beryllium, mercury, and vinyl chloride are now subject to standards. Eliminating epidemiological research seems to be tantamount to giving up on setting annual average standards for other toxic air pollutants. It is equivalent to throwing away the possibility of a program for the vast number of chemicals that we suspect may be harmful, but that we don't yet have information on.

This problem has affected my own research on a number of levels. In studying the acid rain problem, the importance of fine particles immediately becomes apparent. People often assert that the acid rain problem is a problem for fish only. Nothing could be further from the truth. Besides the potential health effects of acid leaching of toxic metals into drinking water, there are direct health effects induced by acid pollutants. The suspended sulfates and nitrates carried in long-range interstate transport make a significant contribution to the TSP levels in several Eastern States. That is, the States cannot solve their own air pollution problems with regard to the fine particles, because they are being impinged upon by contributions from other States.

Furthermore, there is growing evidence of long-range transport of many other potentially toxic substances, including toxic metals. Unless an adequate basis exists for determining the health damage caused by these pollutants, any control strategies we formulate may be inadequate to deal with the damage caused by low levels of ambient particles and toxics.

This difficulty arises not just in the long-range transport problem, but also with respect to synfuels plants, petrochemical plants, smelters and coke ovens, where emissions of toxic air pollutants, particularly polycyclic organic matter, may pose a significant hazard. The projected expansion of synfuels production capacity is a particular concern in this regard. If we eliminate the ability to make judgments about low-level exposures, we cannot make judgments about the health effects of these plants.

Epidemiology is not perfect. But it is a vital tool within a larger repertory needed for standard setting. Effects at the few percent level, which might be identified in a careful study, are difficult to ferret out but are far from irrelevant to society. One extra person in a sample of 1,000 dying each year represents 1 percent in a 10-year study of this group. If the whole U.S. population is exposed to this same level of risk, 200,000 persons die each year from that risk.

As a society, we cannot afford to ignore such risks, difficult as they are to quantify. Thus, I regard epidemiology as a vital component of the EPA research program.

I would like to move on to discuss some other aspects of the program. Another vital component of any control strategy is a detailed knowledge of pollutant levels and impacts. Here we will discuss monitoring. As Mr. Penna said, we need a consistent monitoring program which is of use to scientists and regulators, and it has to be intelligently designed and targeted to obtain information necessary to the formulation of policy.

You can go out and collect as many numbers as you like, but most of the numbers you collect will have no information which is useful to policymakers. In this regard, systematic monitoring of ambient air quality over a broad region of the United States is required to provide a data base for the evaluation of long-range-transport models. Such a monitoring data base must be continuous, and intelligently sited.

Large-scale monitoring of airborne fine particles and toxics is critical to developing an overall picture of long-range transport and to the construction and evaluation of long-range-transport models. These models, in turn, are now providing information which is critical in policy formation. These efforts need to be supported by EPA with continued improvements in the ambient air data base.

With regard to impacts monitoring, I note that the national acid precipitation assessment plan has chosen EPA as the lead agency for support of research on aquatic impacts of acid rain. This type of research is particularly critical if we are to keep tabs on the drinking water quality effects of the leaching of toxic substances due to acidification of water supplies. This is an aspect of the acid rain problem that has not received much attention, but it could be the most important part of the problem, outside the suspended fine particle aspect.

A few remarks on control technologies are in order. The national acid precipitation assessment plan also has designated EPA as the lead agency for research on control technologies. As one who is committed to the necessity of reductions in total atmospheric loadings of SO_2 and NO_x in order to mitigate both acid rain and the long-range transport of fine particles, I am particularly concerned that research on the limestone injection/multistage burner technology be supported. This technology provides for simultaneous cost effective reductions in both of the pollutants responsible for acid rain.

This is particularly important because there are not, at this point, very good controls available for NO_x emissions, and most of the focus has been on SO_2 controls. But in the future, NO_x is expected to become an increasing fraction of the acid rain problem and EPA should be giving support to the development of technologies that can handle both these problems at once. If we just address the SO_2 problem, we may wake up in 10 years and find that we have gotten rid of some of the acid rain, but we are stuck with an equally serious problem related to the nitrates alone.

Various combinations of precombustion control technologies, emission control technologies, and investments in nonpolluting generating alternatives, provide the best hope for mitigating acid rain.

In this regard, EPA should support research on innovative policy methods for pollution control, including such concepts as trading of PSD increments and offsets within the context of regional bubbles and the substitution of investments in nonpolluting alternatives such as end-use efficiencies, hydropower, and geothermal and solar energy for central station power generation. The plan has also chosen EPA as the lead agency for this task.

Finally, I would like to second the opinions of Representative George E. Brown, Jr. and Radford Byerly, Jr., who recently addressed some of these issues in an article in Science magazine. They note that "EPA must build up the best and most creative environmental research program possible," and conclude that "our recommendation is for rigorous, uncompromised research, part of it done in-house."

I fully support these recommendations and I would like to conclude with the strongest possible recommendation that a long-term program aimed at elucidating the health effects of a variety of air pollutants, including epidemiology as one of its components, is absolutely essential to assuring a healthful environment for Americans in the decades to come.

I would like to assert further that we need to learn to come to grips with long-term, large-scale international pollution problems such as the acid rain problem through long-term-research efforts. We also need to learn how to act on imperfect scientific knowledge, which after all, all scientific knowledge is, before irreversible environmental damage becomes catastrophic. In this respect, our attempts to control acid rain are a model for our ability to deal with complex problems that will come at us down the road, such as the greenhouse effect, which must be addressed before their worst effects are manifested.

We cannot afford to sit and wait for the most perfect information to come in because, first, perfect information is a bogus concept; second, by the time relatively perfect information comes in, the game will probably be over with regard to these problems, and we will be in a fine pickle.

Thank you. I will answer any questions.

Mr. **Scheuer**. Thank you very much, Dr. Oppenheimer.

We are going on the 5-minute rule because time is pressing on us. We need to be out of here at noon.

Mr. Penna, on page 3 you state that EPA's first attempts at risk assessment involving air pollution was severely criticized. Mr. Swan also criticized the risk assessment efforts. We are very concerned here that the regulatory process not go beserk, not go out of control. I don't think anybody up here is looking for a risk-free environment, and we are looking for answers and we are looking for processes that are cost-effective that will not unduly burden industry and commerce.

We know there will be some cost. Nobody ever suggested that we could do these things without any cost. But we are not looking for a nirvana. We are not looking for a risk-free environment. We want to be sensible. We certainly do not want to cripple our industry for competing abroad and selling goods and services around the world, which is a desperate problem now that we are in.

So the whole matter of establishing the standards that are rational, that are sensible, and that are cost-effective is very, very important to us.

Can you give us the nature of the criticisms of the EPA's first attempt at risk assessment, whether the target of these criticisms has been corrected? And if so, what further corrections do you think ought to be made?

Mr. **Penna**. Well, Mr. Scheuer, the criticisms were in two directions on the particular standard that I cited in my testimony—that was the ozone standard. Criticism first was on the actual technique itself, that criticism came from the EPA Science Advisory Board, who critiqued the technique. And then some industry groups, notably the American Petroleum Institute, also criticized certain aspects of that procedure. In particular, what they criticized was the judgmental nature of the information which the scientists provided. It was a technique which used the judgments of certain scientists and then weighted, in some sort of quasi-statistical fashion, these particular individuals' judgments to determine the potential risk.

In terms of the improvements that have been made, I think one has to recognize that risk assessment is in an almost embryonic stage; that EPA probably rather than being roundly criticized for doing what they did in the ozone standard, probably should have been congratulated that they, in fact, began to do something.

Now, whether what they did was appropriate or not I think is a completely different question. What our commission suggests that EPA do is undertake a significant research effort to improve risk assessment, and to begin to make more use of risk assessment in the standard-setting process. But the Commission also recommends that risk assessment should not be the sole basis upon which the ambient air quality standards are established, because it is evolving and because it is a relatively new technique.

Mr. SCHEUER. On page 5 you discussed past deficiencies in the major research programs of EPA. I am not going to ask you any specific questions, although I am sure many of us will have additional questions, and I am going to ask unanimous consent that the record be held open for perhaps 10 or 12 days so that any members who do not have a chance to ask all of their questions can submit them to you in writing, and we would await your answers.

But you discussed the deficiencies in research. What do you think the answer is? Might it be an interagency coordinating task force of some kind to help with epidemiological studies? Is interagency coordination a possible solution to EPA's credibility problems, as they have been expressed by you and Mr. Swan?

Dr. PENNA. It may be. But I think one of the suggestions the Commission developed and other people in both the business and the environmental community are also supporting is for more independent review of EPA's both internal work and external work. To some extent that goes outside even the Federal, State Government sector. What would enhance EPA's credibility is to have as good monitoring as possible from the academic community or other outside sources to critique the programs and plans of the agency in the developmental stages; and then to have these groups critique the program as it proceeds to make sure that the bench scientists are doing as good a job as they possibly can.

There must be more of oversight, and certainly in the intergovernmental structure at the Federal level there certainly could be more coordination than there is now between EPA and say the Department of Health and Human Services, the National Institute of Environmental Studies at HEW.

So certainly that is another possibility.

Mr. SCHEUER. Thank you very much.

Mr. Dunn?

Mr. DUNN. I would like to continue in the same vein as the chairman's question.

Mr. Swan, on page 2, 3, and 4 of your testimony you make reference to Dr. Cantlon. Is that John Cantlon, Michigan State University?

Dr. SWAN. Yes.

Mr. DUNN. I thought it was. We go back a number of years, and we have discussed this area.

You seem to be saying that we have this science advisory board, but EPA is not in effect listening to them, and I think I heard Mr. Penna make that same statement. Is that a correct summation, that they are not using this board?

Dr. **Swan**. I think they are using them only in a very narrow sense and far less than Congress intended.

Mr. **Dunn**. My question is, Do we need to direct specific language to EPA to redress that problem?

Dr. **Swan**. I think you do, given the track record of the agency. I think the problem is perhaps caused by the innate dislike of managers to accept outside advice and act on it.

Our experience with EPA, if I can interpolate, is that from a management point of view they appear to decide on some sort of managerial basis the priorities of the agency with respect to regulation and then tell the researchers to produce the evidence to support a predetermined course of action. This is contrary to the way scientific research works.

I think this has led to a great deal of friction, and since the system is operated by managers I think the net result is that the scientists who want to be more independent tend to want to leave the agency and conduct their research in a more favorable framework. This is alluded to by the National Commission on Air Quality, particulary in the field of epidemiological research.

Mr. **Dunn**. Dr. Cantlon is Chairman of the Science Advisory Board, and on page 4 you say Congress should require the Administrator of EPA to consider implicitly the recommendations and advice of an independent science advisory committee. Are you suggesting another committee, or are you suggesting that they simply listen to the same committee? Is that what you are saying to me?

Dr. **Swan**. It could be either.

Mr. **Dunn**. I would think that since we have already one committee functioning it would be simpler not to form another committee but to redirect the language, as I suggested a moment ago, so that we could make use of the committee we have.

Dr. **Swan**. I would agree with that.

Mr. **Dunn**. Mr. Penna, do you have any comments on that?

Mr. **Penna**. I think in the existing act in section 307, if I am not mistaken, there may be some language which requires EPA to respond to comments from the Science Advisory Board in establishing national ambient air quality standards. I think this was done, for example, when EPA established a primary standard for lead. There certainly was a lot of discussion about that in the scientific community. EPA responded to that and that was made a part of the record in the litigation that followed.

Mr. **Dunn**. I think Dr. Swan is proposing a wider scope for the committee.

Dr. **Swan**. Yes. I am suggesting that the committee's full scope, as it was described by Congress in the 1977 amendment, should be implemented.

Mr. **Dunn**. I might suggest, Mr. Chairman, that we take a further look at the language in the act with regard to that. And I thank you.

Mr. **Scheuer**. Dr. Swan, on page 7 you state that reliance on emission reduction is the principal control strategy as a policy of the Clean Air Act with the ultimate goal of zero emissions. Now that is a very serious charge, because if what you say is true we all up here are guilty of gross foolishness. Do you know of anything in the Clean Air Act or anything in the legislative history that states that we are looking for, searching for the ultimate goal of zero emissions?

Dr. SWAN. No.

Mr. SCHEUER. Can you document that statement in any way?

Dr. SWAN. I don't think there is anything in the act that makes that an ultimate national goal. Of course, the National Water Quality Act——

Mr. SCHEUER. We are not talking about the Water Quality Act. I would be happy to talk about it because I am familiar with it. I happen to represent Jamaica Bay, and I can describe to you in infinite detail the improvement in the quality of life of millions of people around Jamaica Bay as a result of its becoming swimmable, as a result of fish, wildlife flourishing there, clams, oysters, shellfish, a variety of sea life that has come back after six or seven decades of that lake being eutrophic. If I am proud of any one thing this Congress has done in the 15 years that I have been here it is the expenditure of hundreds of billions of dollars in our tertiary sewer system that has resulted in cleaning up our rivers, lakes, harbors and our national waters.

But that is another subject. I'm tálking about your statement that the Clean Air Act embodies, relies on emission reduction as a principal control strategy to achieve the ultimate goal of zero emissions. Can you document that in any way?

Dr. SWAN. Mr. Chairman, my statement attempted to be descriptive of the policies, not to identify specific legislative requirements.

Mr. SCHEUER. Wait a minute. I'm asking you, can you identify anywhere, is there a scintilla of evidence, a shred of evidence that indicates that responsible Members of Congress on the Democratic and Republican side ever perceived that it was our mission to produce a zero emission society? That is a very serious charge.

Dr. SWAN. There is no intent in my testimony to assert that there was such an attempt by Congress.

Mr. SCHEUER. You stated it very clearly and unequivocally. Now let me read to you your words again:

> Current U.S. environmental policies, as embodied in the Clean Air Act, follow these general principles: Reliance on emission reduction as a principal control strategy with the ultimate goal of zero emissions.

Now I don't think that I am a fool. I don't think that any Member sitting here is a fool. If we had as our ultimate goal creating a zero emission society with all of the devasting effects that would have on industry and commerce it would virtually put us back into the caveman era and we would be very, very foolish and irresponsible legislators.

I would like to know if there is a scintilla of evidence to support that charge.

Dr. SWAN. The principal evidence I can furnish you, Mr. Chairman, would be the trend of the emission reduction requirements over time.

Mr. SCHEUER. We want to reduce emissions. Does that mean we want to eliminate them entirely and go to the extraordinarily cost-ineffective measures that would be required to do that, the extravagant measures that would have such devastating effects on our industry?

I have been to these hearings year after year after bloody year. I was involved in the 1970 passage of amendments to the Clean Air Act. I cannot remember any Member of Congress or any serious witness ever stating that we should have as our goal zero emissions.

We have discussed that one long enough, and we are on a tight timetable, but I do not think that this helps the credibility of a witness to make a wildly unsubstantiated statement of that kind.

Let me go further down on page 7. You talk about the primary economic burden of emission reduction on the operator, the "polluter pays" policy. Can you identify any witness, any legislative history, that, for example in the case of a utility, ever prevented a utility from passing on the cost of emissions control technology into its rate base?

Dr. SWAN. Not for utilities.

Mr. SCHEUER. If you can't for utilities where they are regulated, and we never impeded them or suggested that directly or indirectly that they could not pass on those costs into their rate base, certainly we did not suggest it ever for unregulated industry. How can you make such a statement?

Dr. SWAN. I can cite the example of our own industry.

Mr. SCHEUER. Did Congress ever tell you, or did the executive branch ever tell you that emission control technology costs could not be passed on as a cost of doing business like advertising, public relations, legal, overhead, manufacture, packaging? It is a cost of doing business. Have we ever described it as anything else?

Dr. SWAN. The ability to pass on cost depends on what the customer is willing to pay, sir.

Mr. SCHEUER. That's correct.

Dr. SWAN. It has nothing to do with regulation. Therefore, the ability of the producer to pass through additional costs is totally dependent on the ability of the producer to raise the price for the product. Now if the price cannot be raised because of international competition, you therefore cannot recover the additional cost.

Mr. SCHEUER. That may be a fact of life, and it is one we are very concerned about. We do not want to cripple our industry and we do not want to impede the cost-effectiveness of our industry. We are deeply concerned about that and we are constantly striving to make this legislation more cost-effective. But you are not saying that this may be a result of it; you are saying that current U.S. environmental policies as passed by this Congress embody the following general principles. And one is that the polluter pays.

Dr. SWAN. Yes, sir.

Mr. SCHEUER. The polluter never pays. The consumer always pays. You are a businessman.

Dr. SWAN. I can speak from my own experience. Nobody has paid Kennecott Copper any money to reimburse us for the investments, the operating cost penalties we have incurred in meeting valid, enforceable environmental regulations.

Mr. SCHEUER. Is anybody stopping you?

Dr. SWAN. We recover revenues in the form of sales volume and dollars, dollars per pound, of what we sell.

Mr. SCHEUER. That includes a whole lot of cost elements. It may include labor costs that are not very efficient if you have unhappy labor arrangements. It may be a tax structure that needs improving. I would like to see our tax structure improved to help business be more competitive overseas and to encourage them to make further investments in research and development. It may mean unsatisfactory patent arrangement. It may mean an industrial plant that is not very efficient as a result of failure to invest in the past. For example, our steel industry, where they have been eating up the capital for the last 40 years since World War II. And as a result today they find themselves in a not very competitive position because foreign competitors in Japan, West Germany, Sweden have far more up-to-date plants, having invested a far higher percentage of their income in research and development and new plant and equipment. Our steel industry failed to do that over an entire generation.

So there are whole other congeries of elements that enter into whether you can compete or cannot compete in international markets. We are very conscious of this, and we are very conscious of the fact that these environmental controls and requirements are an additional burden. There is no question about it. And we are trying to keep them to a minimum.

I don't think anybody would say here that the source of the pollution, the company has to absorb those costs. They are cranked into the cost of the product like any other cost of production, promotion, sales, legal, organization and all of the other dozens and dozens of costs that you have.

I just think that these unsubstantiated broad statements you have made, Mr. Swan, interfere with your credibility with a great number of very excellent suggestions you have and very positive and useful, constructive points that you have brought to our attention.

Can I now recognize Mr. McGrath?

Mr. **McGrath**. Thank you, Mr. Chairman.

Are any of the panel members familiar with the Hempstead recycling plant in my district?

Dr. **Oppenheimer**. I am somewhat familiar with that plant.

Mr. **McGrath**. That is a $100 million waste disposal plant that was opened with all good intention based on a demonstration project in Franklin, Ohio, which worked and up to this point has been closed since about a year now.

The problem is air quality control. It seemingly has an emission called dioxin which closed the plant. There is no EPA standard for dioxin. I understand recently the tests that were made showed that it had a very miniscule amount of dioxin per billion cubic whatever it is, and at the present time neither the local government nor EPA is willing to either open the plant nor set a standard in order to get this facility, which is much needed, off the ground and let it continue to operate. And I am just wondering whether the dragging of the heels—and we are talking about over a year now—dragging of the heels of coming up with some sort of standard is something which is common with EPA or their particular air quality control aspects of their job.

Dr. **Oppenheimer**. I would like to comment on that. The example I was mentioning with regard to the fine particles is analogous to this situation. There seems to be a reluctance to expand the category of criteria pollutants or to expand the category of toxic air pollutants, and I can only see a very serious health and economic situation developing out of this reluctance over the next few years where situations like the one you mentioned come about where we have essentially a new technology with new sorts of emissions. The synfuels production situation is analogous. Someday, a suspect emission will be identified from one of these facilities. The data will not be there; the ability will not be there; the intellectual capital will not have been built up to deal with the situation and to set the necessary emission standards for these facilities.

We will not only have a health problem, but we will also have an economic problem. This leak of information can stand in the way of reasonable economic development.

Mr. McGRATH. How long can we expect that, given the problem, EPA could come up with a standard?

Dr. OPPENHEIMER. That is difficult to answer. I am not an epidemiologist. I am not a medical doctor. It would be disingenuous of me to try to put a number on that, but I can say that there has been a lack of enthusiasm toward supporting research that would give us the answers to such questions. I would think that if a reasonable program to find answers about the health impacts of low levels of exposure were undertaken that in a few years we could have a broad base of knowledge that would help us address this kind of difficulty.

Mr. McGRATH. We have a catch 22 situation here. EPA has shut the plant down but yet it does not have a standard by which the plant could ever open up. There is no way that tests can be performed at this plant because it is closed. So unless they have some laboratory means of coming up with a standard there will never be a standard, and meanwhile a $100 million facility, which was built without taxpayer money, by the way, private enterprise, is going down the tubes, and it is falling down right in front of us, and hopefully this particular technology would be one that could solve a very big problem that we have on Long Island, and that is what to do with our garbage.

Dr. OPPENHEIMER. In this particular case it is better that the plant is shut down than that they are doing an exposure risk experiment on your constituents.

Mr. McGRATH. I have no further questions.

Mr. SCHEUER. Mr. Gregg.

Mr. GREGG. Thank you.

I would like to know what changes are being recommended in the Clean Air Act to deal with acid rain, specifically.

Dr. PENNA. Specifically, the National Commission on Air Quality recommended that by 1990 that there be significant reductions in emissions of sulfur dioxide to address the acid precipitation problem.

In addition, we specifically recommended continuation of research on both the monitoring aspect of the acid precipitation and in the cause-effect relationship. As Dr. Oppenheimer pointed out this morning, that cause-effect relationship still is an area of substantial uncertainty. The Commission members believed, notwithstanding that uncertainty, that there should be action taken, and if we begin today, we would begin to see those reductions on or about 1990.

Mr. GREGG. Dr. Oppenheimer?

Dr. OPPENHEIMER. I am speaking for my own organization, but I think I can speak for the National Clean Air Coalition, also, on this.

We believe that a cost-effective and reasonable program of staged reductions in total emissions of SO_2 and NO_x is feasible. The NCAQ report cites the figure that approximately a 45-percent reduction in total SO_2 emissions could be accomplished with a net increase of less than 2 percent in utility bills of eastern customers, if the cost were averaged over all customers in the East. We think a staged reduction involving a mixture of retrofitting of scrubbers, boiler modifications, load management, investments in alternative energy sources which are less polluting——

Mr. GREGG. Let me break in. What I want to know is what specific changes in the act are required to accomplish—I understand what you want to do. I want to know what specific changes in the act—do you want to change section 1.7 to make regional air quality specific to carrying pollutants, the LRT issue?

Dr. OPPENHEIMER. I think we need a regional cap on emissions. Create a new section of the act, essentially, aimed at reducing emissions loading. It would use staged reductions over a number of years, with an ultimate goal and intermediate goals specified in terms of total load limits to be achieved as of particular years as Congress would choose.

You could pick 1990 and intermediate reductions for 1985 and 1987, for example, and include a method for distributing the costs among, for instance, all utility customers in the East. But the solution has to be regional. The reduction has to be regional, as opposed to being statewide.

Mr. GREGG. Do you have a comment on that, Dr. Penna?

Dr. PENNA. I would probably go along with the fact that there should be specific new provisions to address the question of the reductions from acid precipitation.

But getting to your question specifically about other sections that might be changed, the Commission recommended specifically section 110[a][2][e] and section 126 of the act should be changed in a manner that should allow a State to take actions when a number of sources in other States may be causing a problem in their State. Right now, there is at least some uncertainty over whether this can be accomplished under the existing statute. The act may be limited to allowing an action when only one source is involved. This creates difficulties for a State like New York, for example, since it may make the argument that sources in several different States, or several sources in one particular State, may be causing their problems.

The Commission recommended specific changes in those two sections, as well as an additional section to take care of the significant reduction by 1990.

Mr. GREGG. What do you want to do? How much more money, and how much—what sort of provisions should be made for the investigations?

Dr. **Oppenheimer**. Into research for the LIMB technology? I cannot answer that question.

Mr. **Gregg**. Does it need more money?

Dr. **Oppenheimer**. Yes. Not a lot more, because it is getting to the point where in a couple of more years it will be available. I can provide you those figures after the hearing.

Mr. **Gregg**. I would appreciate that.

What is your evaluation of the Acid Precipitation Act's 10-year investigatory process? You made some comments about it is too long.

Dr. **Oppenheimer**. I think the research plan is good, but it is a research document, and we have to act on this problem before the 10 years are up. If we wait 10 years to get the answers, the problem will have manifested itself in the form of irreversible damage to the environment, which will be extensive, and which, by the way, is very expensive to cope with.

Mr. **Gregg**. Mr. Chairman, may I have a couple of more minutes?

Mr. **Scheuer**. Yes.

Mr. **Gregg**. How can you act on a problem if you have not identified the problem? We do not know whether it is SO_2. Dr. Likens will come out with a proposal that will be a study in New Hampshire that may include nitrates. How do you come up with a proposal that makes a decision, takes direction on what we are talking about?

Dr. **Oppenheimer**. I would say that the whole regulatory process is rife with examples of regulating things before 100-percent knowledge on the subject is available—which I don't think it ever is.

But in this particular case, there is no question about several points: (a) Rainfall, especially in the Northeast, but also in certain parts of the Rockies and California, is abnormally acidic, up to 25 times more acidic than it should be; (*b*) that the source of that acid is fundamentally SO_2 emissions, and secondarily NO_x emissions, at least in the Northeast, and (*c*) that reductions in those emissions of some scale, but of a detailed number which is not specified at this point, can bring about a significant amelioration of the acid rain problem.

Mr. **Gregg**. You will say that the scientific community agrees with that A, B, C, D proposal?

Dr. **Oppenheimer**. I will say that I stand by those statements, and that a majority of the scientists I have spoken to, from a rather broad spectrum of interests—people who represent industry, too—would support those three statements, although perhaps not in public.

Mr. **Gregg**. I wish it were true. I wish I had felt that we had melted this down to an A, B, C cause. The acid rain meeting that you went to—the one you are talking about—we had people there from our office, and they came away with a sense that there is still considerable disagreement as to where we point the finger here, and until we can put a handle on where we will point the finger, I do not want to be a Member of Congress, pointing that finger.

Dr. **Oppenheimer**. The uncertainties reside in the precise amount of reduction of emissions which will bring about what response in terms of reduction of acidity of precipitation; they do not reside in the question of which emissions are responsible for the acidity. I don't think there is any serious question remaining but that sulfur dioxide produced mainly by powerplants, and NO_x emissions produced by both powerplants and transportation, are responsible.

Mr. GREGG. Thank you, Mr. Chairman.

Mr. SCHEUER. We have 15 minutes.

Mr. GREGG. Mr. Penna, do you have any further comment on that? And I notice Mr. Swan, also.

Dr. PENNA. I would defer to Mr. Swan.

Dr. SWAN. I agree that there is a scientific consensus on the source-receptor relationship, which was implied by Mr. Oppenheimer, and I think therein lies the problem, because if we make a mistake on regulation, and we guess the wrong sources, then it is a very cost-ineffective way of dealing with the problem, and is likely to impair the credibility of the agency and the regulatory process. In other words, I think the attempt to regulate before even the problem is fully defined, is unwise and unnecessary—I am not arguing that we have to have perfect knowledge at all. I think our knowledge is so imperfect that we stand serious risk of regulating the wrong emitters.

Dr. PENNA. One of the reasons that the Commission, I believe, put the 1990 date in its recommendation was to allow some time for additional research to be conducted on the source-receptor relationship. One of the things that the Commission studies, indicated was that the time that SO_2 or NO_x resides in the atmosphere after being emitted is very different. Sulfur dioxide has a residence time of up to 6 days, whereas NO_x has a residence time of maybe 1½ or 2 days, which means that you may be seeing effects or more local contribution from emissions of NO_x than for sulfur dioxide.

The Commission wanted to give a little more time for that research to take place, with a little more certainty, and allow the significant reductions by 1990; also give some leadtime for industry to install the equipment.

Mr. GREGG. I would appreciate it if you would keep my office current on what your current thinking is on this issue. It is something that impacts my district directly. I have all of the lakes of New Hampshire being wiped out as a result of this problem, so any information you want to put into my office, I would appreciate it.

Mr. FISH. I am going to followup on the same thing, because it comes as a surprise to me, Mr. Penna, on page 8 of your testimony, to paraphrase, you say that reduction in the elements SO_2 and others, and in the amounts of the compounds, is expected to result in a lessening of acid rain.

And then you go on, a little bit further, and call for—continued research should be placed on the link between reduction emissions and in acid depositions. It comes as a surprise. I thought it was pretty clear where this stuff was coming from.

Dr. PENNA. The Commission, at least, believes, yes, we were pretty certain that it is coming from SO_2, and NO_x. The question becomes the relationship, how much emission reduction one needs in order to get some improvement, and I think that is an area——

Mr. FISH. In order to get what?

Dr. PENNA. In order to get some improvement in—or lessening, let's say, of—acid precipitation or improvement in visibility in the West.

Mr. FISH. If I could interrupt you, I thought it was common knowledge that the lakes in northern New York, Adirondacks, and the Canadians are complaining that the industrial heartland of the United States is emitting, through its smokestacks, largely, and coal-based industries, enough stuff that was killing lakes. Where else is it going to come from if it doesn't come from there?

And second, if it is killing waterways today, couldn't we logically assume without being scientists that any reduction in emissions would be helpful?

Dr. PENNA. Again, it gets into a question that may be more in the domain of Dr. Oppenheimer's expertise, and that is atmospheric chemistry. How much of a reduction in SO_2 will lead to a reduction in sulfates?

There is at least a debate that I am aware of in the scientific community that says that it is not a linear relationship; it is not 1 to 1; if you take out 1 pound of SO_2, you do not necessarily end up with 1 pound less sulfate; that there is at least some critical amount that may in fact cause sulfate; for example, if SO_2 emissions were reduced by 50 percent you may get no reduction in acid precipitation. You may have to go further than that. That is one of the unknowns—the transformation process in the atmosphere.

Something which is analogous to that is the whole question of ozone formation. There is still scientific uncertainty as to how much hydrocarbon and NO_x one has to reduce in order to reduce ozone levels. Everyone will agree—I think there is virtual unanimous agreement in the scientific community—that those two substances in the atmosphere, in combination with sunlight, form ozone. But that is where agreement ends. The disagreement begins as to how much of these emissions you need to reduce. And I think that is what we are saying here. It is a question of how much, and what those transformation processes are in the atmosphere.

Dr. OPPENHEIMER. Could I comment on that?

Mr. FISH. Yes. You know, the ozone problem is going to kill our grandchildren, but I am concerned right now that we can't wait, Dr. Oppenheimer, 10 years, to research as to what the linkage is here. Certainly somebody must have given it some attention before now.

Dr. OPPENHEIMER. I'm glad you brought up that example, Mr. Penna, because we have chosen to regulate photochemical pollutants which are responsible for the production of ozone, in the absence of a complete knowledge of how much reduction of what emission causes what reduction in ozone.

I do not see why everybody makes a big deal about acid rain being a special case. It is not a special case. It is certainly true, as Mr. Penna says, that there is no certainty about the exact relationship between the emissions reduction and the subsequent reduction in acidity of precipitation. But such uncertainty is not a new situation; it is one we are very familiar with. We can, however, say with certainty that substantial reductions in SO_2 will yield some kind of reduction in acid rain and sulfates.

And scientific knowledge is not easy to come by, as it isn't with the ozone problem, and if we wait around for the scientific knowledge to manifest itself, it could be 10, 20, or 50 years. You can't know with these things. By that time, you might be able to write off permanently all of the high-altitude lakes in the Adirondacks and many other lakes as well, in other parts of the country. And I don't want to wait around for that to happen.

Mr. **Scheuer**. And Canada.

Dr. **Oppenheimer**. Yes. Sweden is an advanced case of what may happen here in a few years. In Sweden, their problem has really gotten out of hand. If, 20 years ago, somebody had said to you, several thousand lakes in Sweden would be completely devoid of fish for a reason that we can control, and they said that despite our ability to prevent this situation we are not going to do anything about it, you might have thought the person was a madman.

Mr. **Scheuer**. You say "we," in terms of the United States?

Dr. **Oppenheimer**. No; in this case "we" means humans in general.

Mr. **Scheuer**. Actually, I was with Congressman Udall, with the Interior Committee. I was in France, Germany, England, a month ago, and they are producing, apparently, the pollutants that are causing the acid rain in Sweden. And apparently the Scandinavians are extremely exercised over it, as are the Candians. This matter really takes on not only interregional connotations, but international connotations.

Congressman Walgren?

Mr. **Walgren**. Thank you, Mr. Chairman. Just one thought that has been puzzling me.

Some of the people who argue that the coal-burning powerplant phenomenon is not the true explanation for acid rain. Cite Florida and some place in southern California, where this phenomenon has occurred and yet it is not downwind of any sulfur-burning or sulfate-producing pollution. Is there an explanation for that, from your point of view?

Dr. **Oppenheimer**. Yes. First of all, I would like to say that Florida is downwind from several powerplants in Georgia and Alabama, coal-burning powerplants, as pointed out by the recent PEDCO studies for DOE, and that is certainly one suspected cause of the acid rain.

Second of all, nitrates, which result from NO_x emissions, are a well-known cause of acid rain, and in southern California, with all of the heavy automobile traffic, there can be little question but that the NO_x emitted from tailpipes goes up in the atmosphere and is transformed into nitrates, and gives essentially nitric acid as the acid rain.

If you analyze the rainfall in the East, it is mostly sulfuric acid. It comes mostly from powerplant emissions. If you analyze it in the West, it is mostly nitric acid, because it probably comes from the tailpipes of automobiles.

Mr. **Gregg**. Another question which I get all the time, because I have been raising this issue aggressively, is what explains the Seychelles Island situation?

Dr. **Oppenheimer**. There have been some peculiarly low pH readings in the Seychelles. First of all, the monitoring is uncertain. It has not been carried out very long. I would not call it absolutely reliable.

Second of all, at any isolated spot anywhere, there are local natural sources of pollution, like volcanic activity, which can make the pH of rainfall rather low. In the eastern United States, though, there is no question that the manmade sources are 10 times what the natural sources are.

Third, it is possible that acid rain is a global problem. It is possible that the junk we are dumping in the atmosphere here is affecting what is going on in the Indian Ocean. You cannot write it off.

Mr. **Scheuer**. Is there any scientific evidence to support that hypothesis.

Dr. **Oppenheimer**. Not anything we can call reliable, but there are remote stations that are showing low pH readings. And one possibility is that there is a global acid rain problem due to human industrial sources, not natural sources.

Mr. **Scheuer**. Let's talk about the victim countries, like the Scandinavian countries, the Swedes especially and the Canadians. Do the Canadians allege that the source of the pollutants that bring them acid rain is any place other than the United States?

Dr. **Oppenheimer**. The situation, which I think is generally agreed on, is that on the whole most of the pollution-causing acid rain in Canada comes from the United States, but Canada makes some of its own. However, the relative contributions do vary from place to place.

Mr. **Scheuer**. Put it another way, did the Swedes—I know the Swedes are concerned about the polluting emissions that come their way from England, France, Germany, the Rhine. Do they allege that any of it comes from across the ocean, from us?

Dr. **Oppenheimer**. I would say they are far more concerned with their neighbors. The really global transport only becomes important at spots where there are no sources around locally, so that the only significant source is the very long distance one. However, I am uncertain as to the precise importance of global transport.

Mr. **Scheuer**. If we want to make a thoughtful intervention, looking at the problem from the global point of view, it is reasonable to look at it from the global point of view. And maybe it is more of a regional problem, a European problem—a North American Continent—a European problem, involving England, France, Germany on the south and the Scandinavian countries on the north; and a North American Continent problem, involving the United States and Canada, as well as the east coast and the Middle West.

Should we be looking at it as a regional problem, with basically an environmental monitoring system that are quintessentially regional for the North American Hemisphere and for Europe and Scandinavia? Or do you think we ought to be thinking in terms of having some kind of global environmental monitoring system that would detect global trends?

Dr. **Oppenheimer**. I have no doubt that there should be—and to a certain extent within NOAA, there is a global monitoring network. But right now it is of far more concern that we get a good network in the United States, which we really do not have at this point. But ultimately, we could surely use a comprehensive global network.

Dr. PENNA. In response to one of the issues in the original question from Mr. Walgren, there is, I think, again, without very much dispute, a certain amount of SO_2 that is produced locally, transformed to sulfate. You then have added to that, in the eastern portion of the United States, a portion that comes from in from elsewhere. So some sulfate may be emitted directly or some may result from tranformation on a local scale, and then you have the additional sulfate coming in from distant areas.

And I think, in the Los Angeles area, some of the Commission's studies indicated that a byproduct of the photochemical oxidant reaction in the Los Angeles Basin is nitric acid. Because of the hydrocarbon and NO_x being emitted from automobiles and other sources in the Los Angeles area, you will get nitric acid being formed. And that comes down in the form of acid deposition.

Mr. WALGREN. Thank you, Mr. Chairman.

Mr. SCHEUER. Mr. Swan, on page 2 of your testimony, you state that EPA has relied on erroneous or flawed data in formulating policy-setting standards and preparing regulations frequently enough to cause concern about its basic scientific quality control procedures.

I think we all have reservations about the basic scientific quality control procedures. I would like you to—you also mentioned the manipulation of data in our oral testimony. I would like you to give us any specific examples you may have or erroneous or flawed data that they have used in formulating policy-setting standards for preparing regulations, as well as any examples you may have of manipulation of data. These specifics would be very helpful to us.

And likewise, if either or both of the other two witnesses can give us specific kinds of flawed research that they can point to, specific instances of flawed research, both as to the process and as to the result, that would be very helpful to us.

Dr. SWAN. Do you want me to attempt to respond to that now, sir?

Mr. SCHEUER. You can, or you can do it in writing.

Dr. SWAN. I perfer to do it in writing, if I may.

Mr. SCHEUER. That would be fine. Excellent.

[Information to be furnished follows:]

RESPONSES TO CONGRESSMAN SCHEUER'S REQUEST ON PAGE 79

LINES 1937 et seq. (Insert Line 1963)

1. a. In 1975, EPA Administrator Train suspended the automobile emission standard which would otherwise have gone into effect in 1977 because of concern over sulfate emissions from automobile catalytic converters. Mr. Train concluded that sulfate emissions presented "a real health hazard" based on EPA's so-called CHESS studies.[1/] The CHESS studies proved highly controversial, were the

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[1/] A May 1974 monograph, Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971, concluded that based on epidemiological studies conducted under EPA's Community Health and Environmental Surveillance System program, sulfates caused adverse health effects including increased mortality, aggravated heart and lung disease, asthma, respiratory disease in children and excess risk of chronic bronchitis.

subject of an investigation by this Subcommittee[1] and have been subsequently largely discredited.[2] Four years after this investigation, EPA was still relying on CHESS. An EPA April 1980 draft of the Air Quality Criteria for Particulate Matter and Sulfur Oxides reported CHESS data in its discussion of epidemiological studies of the human health effects of sulfur dioxide and particulates. Members of EPA's Clean Air Science Advisory Committee, reviewing the draft, told EPA staff to include such material in a revised draft only to the extent it met rigorous criteria for reliability. Subsequently, references to CHESS studies were deleted by EPA.

b. On June 23, 1978, EPA proposed changes in the primary and secondary ozone standards based on information contained in a revised criteria document for ozone and protochemical oxidants (44 Fed. Reg. 26962 (1978)). In March 1978, a reviewing Science Advisory Board -- the independent arm created by Congress to provide EPA with authoritative scientific advice -- had refused to approve that same document as a scientifically acceptable criteria document for standard-setting purposes. In February 1979, Science Advisory Board Chairman Whittenberger testified that the Board had asked for revision of the document and was told this was not possible. 1980 Authorization for the Office of Research and Development, EPA: Hearings Before the Subcomm. on Natural Resources and Environment of the House Comm. on Science and Technology, 96th Cong., 1st Sess. 179 (1979).

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[1] The House Science and Technology Subcommittee which reviewed allegations that the CHESS studies had been intentionally and systematically distorted by EPA staff to indicate adverse health effects, while concluding no intentional distortion occurred, did find serious deficiencies and apparent "overinterpretation" of data in the CHESS studies. Staff of the Committee on Science and Technology of the House of Representatives, *Report on Joint Hearings on the Conduct of Environmental Protection Agency's "Community Health and Environmental Surveillance System" (CHESS Studies)*. 94th Cong., 2d Sess. 6, 11-12, 24 (1976).

[2] In 1976, Dr. Patrick J. Lawther, the director of the foremost air pollution health research laboratory in England, said this of CHESS: ". . . despite a vast amount of effort and expenditure, its [CHESS's] execution and interpreation left so much to be desired that the results and conclusions are largely discounted outside the United States . . . ." *Clean Air Act Amendments of 1977: Hearings Before the Subcomm. on Health and the Environment of the House Comm. on Interstate and Foreign Commerce*, 95th Cong. 1st Sess. 1036 (1977).

c. On March 1, 1979, EPA halted all major uses of the herbicides 2,4,5-T and silvex, pending Agency review. This action was taken largely on the basis of an epidemiological study of an area in Oregon showing a dramatic peak in miscarriages two months after heavy spraying of 2,4,5-T on adjacent forest land. The study was widely criticized as faulty by outside investigators, including the Oregon State University's Environmental Health Sciences Center[1/] and in a report issued by the Library of Congress.[2/]

[1/] S. Wagner, J. Witt, L. Norris, J. Higgins, A. Agresti, M. Ortiz, A Scientific Critique of the EPA Alsea II Study and Report (Oregon State University-Environmental Health Sciences Center, Oct. 25, 1979).

[2/] S. Hartman, Case History of 2,4,5-T Regulations (Library of Congress-Science Policy Research Division, Oct. 19, 1979).

Subsequently, an EPA Scientific Advisory Panel, while determining not to review the numerous discrepancies in the epidemiological study, concluded there was no evidence of a substantial hazard to human health or the environment associated with the herbicide use. The most recent EPA efforts to cancel the registration of these herbicides and thereby ban their use, do not even mention the disputed Oregon study.

d. On May 21, 1980, President Carter declared a state of emergency in the Love Canal area of Niagara Falls, New York, and ordered the temporary relocation of families because of possible exposure to toxic chemical wastes deposited at Love Canal. The Deputy EPA Adminstrator stated that the action was necessary to protect the residents' health because EPA health effects studies suggested significant health risks. On May 22, 1980, Dr. David Rall of the Department of Health and Human Services presented a report to a joint hearing of the Subcommittee on Oversight and Investigation of the House Committee on Interstate and Foreign Commerce and the Subcommittee on Environment, Energy and Natural Resources of the House Committee on Government Operations. The report concluded that the EPA study reporting chromosome damage provided an inadequate basis for "any scientific or medical inference from the data (even of a tentative or preliminary nature) concerning exposure to to mutagenic substances because of residence in the Love Canal area."

Mr. SCHEUER. You have been very patient, to go through more than an hour of questions by Members of Congress. You have been thoughtful and forthcoming with your answers, and I would like to thank all of the witnesses for your very helpful testimony.

The meeting is adjourned until tomorrow, where we will meet in room 2325 at 2 o'clock in the afternoon.

[Whereupon, at 12:01 p.m., the hearing was adjourned, to reconvene at 2 p.m., Wednesday, May 20, 1981.]

CLEAN AIR ACT

WEDNESDAY, MAY 20, 1981

U.S. HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS, AND THE SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT,

Washington, D.C.

The subcommittees met at 2 p.m., in room 2325, Rayburn House Office Building, Hon. George E. Brown, Jr., presiding.

Present: Representatives Brown, Scheuer, Walgren, Sensenbrenner, Gregg, and Dunn.

Staff present: Dr. James Greene, Richard Robinson, and William Harvey.

Mr. BROWN. The subcommittee will come to order. Today is the second day of hearings in a series of three held jointly by the Subcommittees on Energy Development and Applications, and Natural Resources, Agriculture Research and Environment.

These hearings have, as their purpose, to examine the status of research and development related to air pollution and explore what areas need improvement, keeping in mind that the Congress will be examining the Clean Air Act for reauthorization this year.

During the course of yesterday's hearing, testimony presented provided an overview of R. & D. needs in air pollution; the importance of the EPA in conducting long-term research to provide a data base by which to formulate and justify standards was discussed as well as the need for consistent monitoring and measurement techniques throughout the Nation.

It is critical at this time to hear from those eminently involved with the scientific, economic and technological activities related to pursuit of clean air. Although we appear to be proceeding under the auspices of a restrained budget, it is my hope that we do no long-term economic or environmental damage in exchange for temporary budget relief. The Federal Government has a critical role in insuring that research needs are properly fulfilled and coordinated. The use of that research by Congress in formulating standards and regulations, and by industry in developing appropriate technological responses to standards and regulations, and by State and local governments in supporting and enforcing standards and regulations must be insured.

I am very pleased to welcome our two panels today to discuss health effects research and monitoring and control technology. Our procedure will be to ask each witness to speak for about 10 or 15 minutes so that there might be time for questions, and to feel free to summarize their statement in whole or in part as they see fit.

Our first panel this afternoon will be Dr. Lester Lave of the Brookings Institution, Dr. Daniel Menzel of the Duke University Medical Center, and Dr. Robert Frank of the National Commission on Air Quality. They will address, in whole or in part, as they see fit, the question of the health effects of air pollution.

We are not trying to constrain the witnesses in any fashion in their testimony, but we are trying to develop a complete record which will be of value to the Congress as we consider legislation on this important subject later on in the year.

Can I ask the three panel members to come to the table at this time, unless they are too bashful? [Laughter.]

Do you have the right names in front of you? All right. We will start from your right and my left. We will start with Dr. Lester Lave.

We are very pleased to have you here, Dr. Lave. We note your article published in the current *Science* and your other examples of erudition in this field, and we look forward to your testimony.

STATEMENTS OF DR. LESTER LAVE, BROOKINGS INSTITUTION; DR. DANIEL MENZEL, DUKE UNIVERSITY MEDICAL CENTER; AND DR. N. ROBERT FRANK, CHIEF, HEALTH AND ENVIRONMENTAL ASSESSMENT DIVISION, NATIONAL COMMISSION ON AIR QUALITY

Dr. LAVE. Thank you, sir, you are very kind.

I will address a few issues regarding the research and development expenditures of EPA in a time of budget stringency. The central point I want to make is that at a time like this, it's particularly important to consider that there are not enough funds to do everything that one might want to do. It is particularly important to look at priorities that EPA must set, to look at what EPA could possibly accomplish, and more importantly, to look at what kinds of activities could be done better by some other Government agency or some other party.

In particular the vast expenditures that had gone into research on abatement technology have been largely wasted. The vendors like to develop their own technology so they can patent it and make money off of it. When the Government develops the technology, it is very hard for the vendors to make money and they tend not to promote it. The Nation might have gotten more pollution abatement if EPA had not done the research.

A second area of EPA research and physics of air and water pollution. There the Government ought to be doing it, but there are other agencies of the Federal Government which have played a central role in these activities, particularly the National Center for Atmospheric Research and the National Oceanographic Agency. Here, EPA's activities must be carefully coordinated with these other agencies and, frankly, EPA should be getting them to take a larger share of the burden.

The last area that I want to look at is research on the effects of pollution. Here I suspect that the EPA, in the past, did not pay as much attention as it might have because it had a very strong statute it could hide behind.

The Congress had spoken in the Clean Air Act Amendments of 1970, and one might ask why EPA should bother to justify abating pollution by estimating benefits. However, it's clear that when EPA didn't make a strong case for abating pollution, intense controversies have resulted. One example is the photochemical oxidant standard and another is the sulfur oxides standard. In the latter, industry justifiably points out that the costs of abating this pollution are huge, and there must be something more to go on than a wisp of scientific evidence.

EPA regulation of air pollution involves annual expenditures of billions or tens of billions of dollars. We have to have a much better justification for the expenditures than simply a hint of scientific evidence.

That gets me around to the question of whether additional evidence would really prove to be fruitful in the process. If the statute requires EPA to require the best available control technology, then there is relatively little point in developing estimates of the benefits of abatement because it cannot change any decision.

If, instead, the statute were one that required some look at the benefits and costs of abatement and tried to be quite selective in terms of what pollutants were abated and to what extent, then this evidence would be of immense use.

I would like to finish up this brief opening statement by saying that I would think that the primary area which EPA has neglected in the past and where expenditures have to be increased in the future is the effects of various air and water pollutants. The research must take a wide-ranging look instead of going with any single set of professionals.

EPA research must have a longer time-horizon than it has had in the past. After all, even though EPA has not spent vast amounts of money on health effects research and other kinds of effects research in the past, if that money had been spent with an eye to developing the record for the longer term instead of putting out fires, then we would be much further along.

In summary, there is a need for a change in emphasis at the agency and probably a change in statute as well.

[The prepared statement of Dr. Lave follows:]

PREPARED STATEMENT OF DR. LESTER B. LAVE, BROOKINGS INSTITUTION

The major problem with EPA's research and development effort over the past decade is failing to realize that the agency cannot do everything. Even with a budget in the hundreds of millions of dollars, the capacity of the agency is limited to conduct basic research on biology, develop and test control technologies, investigate monitoring, and investigate the effects of pollutants. The budget will not stretch over all these missions. Indeed, expenditures in some areas such as control technology may be dysfunctional, delaying the time when good technology is marketed.

In these times of budget cuts and budget stringency, the point is even more central. EPA must examine carefully what must be accomplished, setting out priorities, resources required, and probabilities of success. But this is only the beginning. EPA must go on to examine what efforts will be handled almost as well, as well, or better by other agencies, state and local governments, or the private sector. EPA must then encourage these others to shoulder their responsnibilities while it concentrates on the activities which others will not do, or at least will not do within the required time period.

The best example here is R. & D. on abatement technology, which has taken the largest share of EPA funding. While some work, particularly on basic technology, is appropriate, the vast majority of these funds were not well spent. For technology developed by EPA, no private company had an incentive to adopt and market it; they could not patent the technology or gain an advantage over their competitors. No company had a proprietary interest in the abatement technology. I would guess that at least as much progress in abatement technology would have been made if EPA had promulgated its regulations but left development to the private sector.

A second example of smaller magnitude is the expenditures on diffusion and air and water chemistry. While there is no direct profit to be made by developing these models, companies have been willing to spend large sums to develop these models in order to show that they will be in compliance with EPA standards. A more important role is played by organizations such as the National Center for Atmospheric Research, which spends vast sums on atmospheric diffusion models. This is an activity that EPA should be supporting, but the support should be coordinated with work done by other organizations and private companies to ensure that the funds are spent beneficially.

To a small extent, some private companies have sponsored research on the effects of pollution. However, these studies have generally been ones of limited nature that could not discover the general impacts. Unfortunately, no other organizations have studied effects. Although this question is central to the mission of EPA, since it explicates the social and ecological consequences of various types and levels of pollution, EPA has given the area short shrift. EPA has tended to regard the desire to clean the environment as given and viewed its mission as finding the quickest, most effective ways of abating emissions. However, the elementary truth of the materials balance approach is that there will always be residuals; one can change the chemical form, location, and medium of emission, but one cannot stop emission. Effects research is needed to clarify the implications of emissions of each particular chemical form, in each location and medium. Without these facts, there can be no intelligent environmental policy. I believe the failure of EPA to focus its R. & D. effort on effects research is a major failure that will become increasingly unfortunate over time.

Effects research is a complicated area, involving human health and aesthetics, materials damage, and damage to plants, animials and ecosystems. A variety of approaches are needed involving a variety of investigators. This area is not so advanced that a single method or even narrow range of methods can be identified as the only appropriate ones. Instead, a wide range of methods must be explored, with an evolving strategy based on past contributions and future promise. I submit that no one could justify EPA's expenditures on health impacts of air pollution on the basis of past contribution and future promise.

Should the agency be allocating its R. & D. funds to outside grants or to intramural activities? Any reasonable analysis shows that outside grants are more productive per dollar than intramural research. The government generally has to pay scientists more than academic institutions. Furthermore, government scientists continue to be employed, even when their research no longer seems productive. In contrast, a competitive grant system funds only the most promising projects and cuts off researchers when their ideas no longer pass peer review. Thus, I conclude that the vast majority of funds should be allocated on the basis of peer review to outside scientists.

At the same time, there is a need for scientists inside the agency to interpret findings, advise policymakers, and review research. Good scientists can be hired only if they are offered the opportunity to do research. Thus, there is a need for an intramural research program, but its size should be tailored to the needs for scientists to perform these other activities.

It would enhance the effectiveness of research to be able to provide multi-year funding guarantees so that large or long projects could be completed. Some projects should be responsive to current policy concerns while others should take a longer term view and search for results that could not be obtained in less than half a dozen years.

A last issue is the level of funding for effects research. Various estimates indicate that the cost of meeting EPA's air pollution regulations exceed $10 billion per year. Yet, as made apparent by the draft criteria document for sulfur oxides and particulate matter and the review of the photochemical oxidant standard, there are major uncertainties about which pollutants at which levels are harmful to health. While much of the uncertainty is inherent, careful investment of some millions of dollars during the past decade would have done much to clean up the current questions. Not only would the reviews of the standards of various pollutants be less acrimonious, but the research could have clarified which pollutants were the culprits, what were the appropriate standards, and helped to save billions of dollars per year in abatement costs and social disruption. It is false economy to withhold millions of dollars from research at the ultimate cost of billions of dollars per year to the economy.

At the same time, I do not want to be naive about the role of science in formulating pollution policy. If the standards are based on available technology and the financial capacity of the industry rather than damage to the environement, research on effects will contribute little to improving policy. The research can pinpoint the pollutants of greatest concern and focus society's resources, but will not increase expenditures on abatement. The desire for a clean environment has ebbed little since 1969; however, there is now recognition that the costs to be imposed on the economy must be limited and scrutinized. Thus, the importance of knowing benefits and costs is must greater than during the early 1970s. However, EPA's statutes and decision making must be changed to emphasize the benefits and costs of pollution abatement and the role of scientific information. Policy must focus on getting the greatest social benefits for a given expenditure rather than on social rhetoric and grand gestures.

Mr. **Brown**. Thank you very much, Dr. Lave. That is an excellent, quick overview of some very complicated problems. I would like to ask each of the witnesses to proceed with their statements first and then we will interrogate all of you collectively. Dr. Menzel?

Dr. **Menzel**. Thank you very much, Mr. Chairman. I would like to thank you for the opportunity to discuss with you some of my views about the research needs of health effects in particular in air pollution.

I have attempted to focus in my written statement more on those aspects that might be of interest to you in terms of the reauthorization of the Clean Air Act. I would like to preface my remarks by pointing out that I currently serve as chairman of the Toxicology Study Section for the National Institutes of Health as well as being on the Health Research Review Panel for EPA, the Science Advisory Board for EPA and the National Science Foundation, so I have included some remarks that impinge upon all of these agencies as well as those that deal specifically with EPA.

I would like to start off by bringing some sort of perspective to the time that is required for research efforts to be completed and to be useful in the fund of knowledge upon which EPA or any other agency might act.

Currently, you as the Congress have asked that a 5-year cycle be set forth in the Clean Air Act for the review of current evidence. I believe that this is reasonable, and I certainly would urge you to maintain that cycle and not to consider shortcutting the review cycles to less than 5 years. It is not possible for us to bring to you new information of usefulness in a shorter time.

I have chosen five issues which I have listed in my written statement. The first is a more precise definition of the human health effects from air pollution. Second is the question of research leading to dosimetry and extrapolation of animal experiments to man; third, the development of methods to estimate the benefits to man of regulation of air pollution; fourth, the relative merits of directed versus unsolicited research programs, and fifth, the manpower needs for an adequate national research program. I would like to address them very briefly in that order.

First, with regard to the question of a more precise definition of human health effects in air pollution, I think that there is a tendency to approach this from a very simplistic viewpoint and to attempt to suggest to you that some sort of a universal definition of adverse health effects of air pollution might be possible.

On the other hand, our knowledge of the chemistry and toxicology of air pollutants would suggest that there are many different effects that will result from the inhalation of air pollutants and, therefore, it is not going to be possible at the present time or even theoretically anticipated that any single simple definition of adverse health effects would be possible. This, unfortunately, has led to a great deal of misinformation, some of which has appeared recently in the economics literature with regard to estimating the costs and the benefits from regulating air pollutants.

I would suggest that there are fundamental principles in toxicology of use but that toxicologists have not properly communicated these basic principles. This has led, then, to what I feel is very erroneous interpretation in some economic surveys, such as are enumerated in my testimony.

With regard to the second area, that is the question of dosimetry and extrapolation, EPA has been very reticent to utilize extrapolation from animal experiments to humans whereas other agencies have embraced this concept. I would like to point out to you that this is the fundamental basis of experimental medicine. We would not be at our present state of advancement in medicine had we not utilized animal experimentation to its fullest.

I would suggest to you that there are some recent advances, coming to us mainly from anticancer drug therapy, that could be applied in a more rigorous fashion to estimate the human toxicological effects of inhalation of air pollutants through the use of a physiological, toxicologically based mathematical model from animal experiments. This is a new area of research that has not been utilized fully and has the advantage that it has been successful in at least one application, and that it can be applied to other areas of toxicology—community air pollution as well as occupational exposure. It is quantitative and rigorous and, therefore, reduces the amount of bias and debate that might be evoked with less intellectually rigorous exercises. Through the use of such models, the effects in man of exposure to ambient air pollution can be critically estimated. Animal data becomes much more predictive.

A second area of research need for dosimetry and extrapolation aside from modeling the time-effect relationship of air pollutants in man. From animal experimentation, the effects of NO_2 and perhaps of other air pollutants, are delayed until after exposure. This effect compounds and confuses epidemiological studies.

Last, I touched very briefly on the question of indoor versus outdoor pollution and the difficulties that result in ascribing effects to specific air pollutants.

The question of benefits estimates from air pollution regulation can, in fact, be approached. We should recognize, though, that it is, to us in air pollution toxicology, a departure from past work since the Clean Air Act really never implied that benefit analysis was a major area of emphasis. Accordingly support for research in this area has been very minor. Benefit analysis would require, in my view, the development of appropriate new kinds of methodology to assess the benefits. The analysis of costs are easier, but the benefit analysis should represent a new major investment in terms of research dollars.

I don't think that our present level of effort in benefit analysis is adequate without a budget increase. Shifts within the present research budget will result in a significant detriment in our effort in our areas. I suggest a heretical theory akin to some of the theories of chemical carcinogenesis as one method to approach benefit analysis, and I have termed it the multiple-hit chronic disease model. It just points out to you that there is a way, conceptually at least, to approach the problem.

I would like to address just very briefly this question of solicited versus unsolicited research and how this might meet EPA's needs, or fail to.

One thing we must keep in mind is that EPA does have a need for solicited research. I believe also that without an appropriate research effort within EPA, there will be no appropriate resolution of the problems which EPA is mandated to solve.

The unsolicited research program, which is referred to as the grants program, really does need support. It's very embryonic. It's not going to provide, however, a short term solution to any of EPA's problems. It is a way in which basic research could be emphasized, and in the past, EPA's effort on basic research has been dismal at the best.

It is a way, also, of recognizing that epidemiological studies, a major effort of EPA in the past, have certain limits, and they have probably reached these limits. It is necessary for us to consider new areas.

One problem that I would like to call your attention to is addressed by Dr. Branscom, the chief scientist of the IBM Corp, regarding the crisis in capital equipment in the universities in the United States. He has made a very good case for the need for support for capital equipment in research, and I suggest to you that you ought to hear from Dr. Branscom in more detail as to what his views are.

I have some criticisms of EPA's current solicited research in that I believe the current assembly of research committees are ineffective and do not meet EPA's needs. I also would suggest to you that Congress could encourage other agencies, such as the National Institutes of Health, the National Science Foundation and Department of Energy, to carry out research in the area of health effects of air pollution.

Basically, EPA has done this by itself, and I see very little effort by other agencies to support this.

I would like to conclude by making a plea to you for manpower needs, and especially training with regard to toxicology and especially toxicology as it relates to air pollution effects. We are indeed facing a very critical situation. The support of young scientists is declining and, therefore, the number of scientists available to meet the research problems of the future will be inadequate.

It is not just a question of being self-serving in wishing to have more graduate students. It is really a very critical problem that I think deserves your attention.

Lastly, I would like to point out that a shift or emphasis toward this problem of risk assessment really means that we are making a major change in our philosophy as to how air pollution should be viewed. I hope that we will not make such a major and drastic diversion that, in fact, the overall original goals of the health effects are lost in this exercise.

Thank you.

[The prepared statement of Dr. Menzel follows:]

Testimony of Professor Daniel B. Menzel

Duke University Medical Center
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(919) 684-3915 or 684-2927

Before

The Energy Development and Applications Subcommittee
Of
The Committee on Science and Technology
U. S. House of Representatives
Washington, D.C.
May 20, 1981

Mr. Chairman and Members of the Committee. Thank you for this opportunity to discuss with you my views of the research needs in the health effects of air pollution as they relate to the reauthorization of the Clean Air Act. Let me say at the outset that I favor the reauthorization of the Clean Air Act, especially the continued support of research related to air pollution and in particular the health effects of air pollution. The U.S. has made great strides toward cleaner air. Much has been learned about the health effects of air pollution, but much remains to be done. The nation will continue to profit from regulation of sources of air pollution and research into the health effects of air pollution. While the general improvement of the quality of our air has led some to suggest that regulation and research are no longer needed, I would suggest that there are definitive areas where added research must be carried out to understand fully the health effects of air pollution and, therefore, to make wise choices in regulation. I think it particularly important that the health effects reserch on air pollution should be carried out continuously. To assure that a continuous updating of the research results of the health effects of air pollution reach the regulatory process, the current periodic review of the information on the health effects of every regulated pollutant should continue at its present five year cycle. To shorten the cycle to less than five years is unrealistic, given the limited resources available and the time required to conduct the biological studies. As new research results become available, it should be recognized that the evidence may dictate either more lenient or stringent standards. I also think it necessary that the research continues to be an essential, strong part of the role of the Environmental Protection Agency (EPA).

I should like to address specific issues of air pollution health effects research:

1. A more precise definition of human health effects from air pollution.
2. Dosimetry and extrapolation of animal experiments to man.
3. Development of methods to estimate the benefits to man of regulation of air pollution.
4. The relative merits of directed vs. unsolicited research programs.
5. The manpower needs for an adequate national research program.

1. The Need for a More Precise Definition of Human Health Effects from Air Pollution

A more precise definition of the adverse health effects of air pollution still remains the primary research need of EPA for carrying out its mission in implementing the Clean Air Act. As I will discuss below, there is no universally accepted definition of human health effects of air pollution. Some have consequently ignored human health effects in defining the costs of and benefits of air pollution regulation (S. Gerking and W. Schulze. What Do we Know about Benefits of Reduced Mortality from Air Pollution Control? Amer. Econ. Rev. 71: 226, 1981).

Ignoring health effects does not make them go away. Being dissatisfied with the manner presently available for quantitating their effects on the U.S. economy also does not provide society with a wiser serids of choices in regulations. I would suggest that the translation of basic health research into terms understandable by a broader public, including economists and regulators, should be a general goal in toxicology.

Why is it so hard to define the adverse health effects of air pollution? Polluted air, as we are breathing it this moment in the Capitol of the United States, is a complex chemical mixture, so complex that many of its components are still unknown and the chemical reactions that produced this mixture are also unknown. We do know and can measure the major toxic components. These have been recognized as the so-called Criteria Pollutants, meaning that these compounds have been designated by EPA as being important enough to human health to be selected for study, publication of a criteria document dealing with them, and promulgation and enforcement of a National Ambient Air Quality Standard for them. But the criteria pollutants are chemically very different from each other. Although they are all gases and are inhaled by man to produce their toxic effects, the physiological, biochemical and pathological effects of these compounds are widely different. There is no toxicological reason why they should be similar. Confusion has arisen because some of these pollutants can affect human and animal breathing patterns in similar ways. Also, because of technical problems, breathing patterns (respiratory function) is often the only safe way to determine the effects of these pollutants on human volunteers. In animal experiments, more sensitive methods can be used. These cause irreparable damage to the animals, however, and we can not subject humans to similar damage.

The respiratory tract has a limited number of ways in which it can protect itself against an inhaled toxicant. Consequently, a variety of chemicals produce narrowing of the airways, coughing, and difficulty in expiration on short-term exposure even though the chemicals react with the lung by very different means. The differences in chemical reactivity can be best studied in animals where the more destructive methods of biochemistry can be carried out. Mathematical relationships and dose-response curves can be constructed for animals exposed to given air pollutants with precision and confidence.

Reading criteria documents describing the effects of nitrogen oxides, photochemical oxidants, ozone, sulfur dioxide and particulate matter will present an apparently confusing picture of a wide variety of biological effects, some even in organs as distant from the lung as the liver. This diversity does not mean that these effects are not important or that they do not occur in man or that they are artifacts. These responses represent the chemical diversity of air pollutants.

The question is: How are these effects connected to specific human diseases, if at all? These connections can be made for some, but not all, of the biological effects observed in animals exposed to specific air pollutants. Probably, some connection will be made between human disease and the majority of the presently known effects.

The Congress, in its reauthorization of the Clean Air Act, should recognize the lack of scientific evidence supporting any universal definition. Support of a basic research program of the health effects of air pollution, in my judgement, is the most direct method of reaching a definition of the adverse health effects. I do not believe that sufficient research has been completed to accept any single definition for all air pollutants, or for that matter for all toxicants.

2. Dosimetry and Extrapolation of Animal Experiments to Man

One of the most pressing research needs in air pollution toxicology is a means of more quantitative extrapolation from animals to man. The weight of scientific evidence clearly supports the toxicity of the major components of polluted air: ozone, nitrogen dioxide, carbon monoxide, and sulfur dioxide. All of the constituencies having an interest in air pollution agree to the toxicity of these compounds. The toxicity of several other air pollutants is more controversial, but still a list of the most toxic components could be drawn up and agreed upon. This agreement has come mainly through the study of animals exposed to relatively high concentrations of these air pollutants. Most studies of nitrogen dioxide, for example, have been at levels 10 to 100 times those occurring in urban air. The argument has become: What is the dose-response relationship between air pollutant concentration and health effects? In other words, are the effects observed in animals at high concentrations applicable to man breathing much lower concentrations? Much of the problem comes back to our lack of understanding of the mechanisms of toxicity of these air pollutants. In the cases of ozone and nitrogen dioxide, it is clearer that the chemical action of these air pollutants on the lung is so rapid and vigorous that the action is likely to be the same in man as in animals.

It is simply unethical to expose intentionally human volunteers to concentrations of air pollutants that produce the irreversible damage already demonstrated in experimental animals. Thus, animal toxicological studies are an essential part of health effects research. Unfortunately, it is not technically possible to detect the reaction of air pollutants directly in the lung or other organs of either man or animals at the present time. It is necessary to rely on indirect measures which are generally so destructive that the animal must be killed prior to the determination. The tissue samples needed for pathological examination or biochemical analysis are, therefore, also not appropriate for human experimentation except in highly restricted situations.

A series of sensitive short-term human experiments, generally using pulmonary function or changes in the mechanics of breathing as the principal human experimental tool, has been developed in place of the methods used in animal studies. These methods are difficult in animals and generally not as sensitive as the biochemical and histopathological methods. There is little information to relate the human methods to the animal methods.

What is now needed is a means to translate the data in animals to man. One approach which has been highly successful in the development of anti-cancer drug treatments has been the development of mathematical models to bridge this gap. One general method to approach such mathematical models is to perform experiments to determine the rate at which the air pollutant will react with specific body chemicals. These chemical reaction rates are combined with the known physiological properties of the lung and other body organs and the physical properties of the air pollutant in a mathematical model. Using such a mathematical model, it is possible to calculate how much air pollutant will reach any part of the lung and how much will react chemically with the lung. Since the chemical reaction of the air pollutant within the lung is the same in experimental animals and in man, and since the physical and chemical properties of the air pollutant are constant, these models can be extrapolated from animal lungs to human lungs with confidence. What is needed is an aggressive campaign to conduct the chemical and biological experiments needed to provide the fundamental data for solving the mathematical equations in rodents and then applying these to man.

A key feature of this approach is that the fundamental properties of the lung, for example, can be used for estimating the effects of more than one air pollutant. Changes in the lung brought about because of age (either young or old) or because of disease (asthma, bronchitis, or emphysema) can also be incorporated. Should new or unrecognized air pollutants become of interest, the majority of the mathematical model is still useful. Other toxicants aside from air pollutants can also be analyzed by this type approach.

Using mathematical models, the effect of certain concentrations of air pollutants in animals can be estimated in man. As more information is gained about the physical structure of the human respiratory tract, such models can be refined to be more precise. Modeling also makes arguments about differences between animals and man more quantitative and, therefore, resolvable on the basis of experiment. Perhaps, differences in effects in animals and man can be understood due to differences in the dose reaching specific parts of the lung. For example, in one model of ozone uptake in the rabbit and human lung, Miller et al. (F.J. Miller, D.B. Menzel, and D. L. Coffin. Similarity between Man and Laboratory Animals in Regional Pulmonary Deposition of Ozone. Environ. Res. 17: 84, 1978) found that the region of the lung most harmed by ozone in the rabbit received almost twice as much as the same region in man at the same gas concentration. Therefore, the effects in the rabbit may occur at lower concentrations than in man. These results can then be combined with EPA's air monitoring network data and projections due to different control strategies to predict the risk to man of specific air pollutant concentrations.

An important issue is the relationship between when a person is exposed to an air pollutant and the time at which the effect of the pollutant is detectable. Since air pollution occurs in a cyclical manner and with large peaks, the time between exposure and effect could be very important if there are residual effects. With nitrogen dioxide, such a carry-over of effects seems likely because the toxic effects of nitrogen dioxide do not appear instantaneously on exposure. A time lag of about 7 to 16 hours occurs in animals. This time lag may result in an increased effect or synergism by exposure to peaks of two air pollutants. In mice, the susceptibility to airborne pathogens is synergized by exposure to peaks of nitrogen dioxide and ozone not unlike the peaks of these pollutants in the urban air. Here is an example of the interactions of animal toxicology and epidemiology. The segregation of health effects with time is essential if one is to estimate the effects of a given concentration of air pollution on a particular population.

A specific issue is the role of indoor vs. outdoor pollution. Recently several studies have correlated the susceptibility of children and adults to respiratory infections and the use of gas cooking stoves in the home. Peak levels of nitrogen dioxide of near one part per million for two hours have been found near gas stoves and are in excess of those in outdoor air. These levels of nitrogen dioxide caused increased susceptibility to infection in adults and children and are very similar to those producing increased susceptibility to airborne infections in experimental animals, especially mice. Thus, the increased susceptibility to airborne infectious agents caused by air pollutants is a general phenomenon. The basic mechanism for this susceptibility is not known and should be investigated.

These are but two parts of a needed effort to extrapolate air pollution effects on animals to man.

3. Development of Methods to Estimate the Benefits to Man of Regulation of Air Pollution

Most of the efforts on estimating the economic consequences of air pollution regulation have centered on the costs of specific strategies or alternatives between different strategies. No method has been agreed upon to estimate the benefits from regulation of air pollution. While there is general agreement that health benefits do occur from regulation, estimation of the benefits from regulation are particularly difficult in terms of the health effects. Lacking such a method, economists have tended to ignore the health effects entirely. The Clean Air Act, on the other hand, places health as its paramount concern. Discussion and study of these opposing views is a proper and important research function, and a concerted attack on this problem is needed.

Because of our preoccupation with the general problems of cancer, most benefit analysis and fundamental research has focused on cancer cause. From present data, it is easier to estimate benefits from avoidance of carcinogens than to estimate toxic effects from chemicals. It has been the accepted policy of the government that cancer is initiated by chemicals by a single interaction of a carcinogen or its metabolite with the genetic material. The "single hit-linear dose response" model of cancer cause makes benefits easily obtainable. (This idea of cancer cause is very simple but likely to err on the side of safety.) On the other hand, the production of chronic disease by an air pollutant does not involve such a simplistic idea. It is not likely that a single air pollutant molecule produces any significant effect. Multiple interactions are needed before the chronic diseases associated with air pollution effects are recognizable. Nitrogen dioxide exposure of rats to two parts per million or greater for a lifetime is required to produce emphysema. The incidence of emphysema is 100% in the population of exposed rats. No information is available on the incidence of emphysema at lower concentrations or on the production of emphysema following shorter times of exposure.

It is difficult to correlate dosimetry models with the prevention of chronic human disease. Research is needed to reexamine existing air pollution data, both human and animal, to construct similar theories relating the incidence of chronic lung disease with specific levels of air pollution. Such theories should be testable by experiment. A "multiple hit chronic disease" theory can then be used to determine the relations between specific respiratory diseases, for example, and human exposures using the dosimetry measurements as a guide to the number of "hits" or chemical reactions between lung tissue and the air pollutant needed for a given incidence of disease.

Given these numbers, it is possible to calculate the number of chronic diseases of a specific type produced, in theory, by a certain air pollutant exposure. The benefits of reducing air pollution from one level to another then can be calculated in terms of the number of incidences of chronic disease avoided or prevented. Once the number of cases of chronic disease is calculated, economists can estimate the benefits by a number of conventional methods. Admittedly, this approach is as simplistic as the current cancer policy, and perhaps even more simplistic. It does illustrate that estimation of the benefits of air pollution regulation in terms of human health are potentially possible, even though there may be difficulties in collecting data, developing credible theories connecting human and animal disease, and in calculating the incidence of chronic diseases avoided or prevented.

4. Solicited vs. Unsolicited Research

Research in air pollution should be directed toward definite problems and the production of information of use in solving those problems. To ignore the use of EPA supported research in regulation leads to a confused and inefficient program. That is not to say that basic or fundamental research should not be undertaken or supported by the EPA or other agencies of the federal government in support of air pollution research. Research support by EPA, in particular, should be balanced between the definitive needs of EPA in regulation and the support of basic research addressed to the broader questions of air pollutant toxicology.

There is no doubt that the past record of EPA in support of basic research has been dismal. The current effort to develop an unsolicited basic research base through a "partnership with the research community" is a commendable endeavor, but the EPA can not hope to meet its research needs for the next five years through this program. Having served on the Health Research Review Panel of the EPA evaluating unsolicited grant proposals, I have observed that the vast majority of the proposals are really outside the scope of the EPA's needs.

Those grants which have been supported are long-term and not likely to meet specific regulatory information needs within five years and more likely after ten years.

The present status of basic research directed toward the toxicology of ambient air pollutants remains unsatisfactory. The reasons for this, in my judgement, are two-fold. First, the EPA has not embraced a fundamental or basic research approach to understanding the causes of the toxicity associated with air pollutants. Only recently has EPA sought research into the basic chemical, biochemical, physiological, and pharmacological basis for air pollutant toxicity. EPA has been reluctant to follow the proven paths of extrapolation of health effects research in animals to man and, as a consequence, has relied heavily on epidemiological evidence, the limits of which are now becoming evident. Thus, EPA's investment in understanding mechanisms has come only in the last three years and has been insufficient to understand any one air pollutant, let alone the complex mixture which occurs in ambient air.

The second reason is the low level of support for air pollution toxicology by other research agencies. A few projects have been supported by the National Institutes of Environmental Health Sciences, but this has not been a major area and certainly not as well supported as the area of toxic chemicals, for example. Little support has come from the other Institutes of Health, and very little from the National Science Foundation. The Department of Energy has centered its efforts within the National Laboratories where little toxicological expertise exists. Thus, EPA has borne the burden almost alone.

The regulators in EPA have failed to recognize that without basic information on the mechanisms of action of air pollutants, prediction and extrapolation from necessarily limited experiments to man are not possible. There has been little appreciation of the need for basic research to provide hypotheses for testing in epidemiological studies and vice versa. Many of the criticisms of EPA-supported epidemiological studies are due to the lack of clear-cut hypotheses to be tested by the epidemiologist based on animal or clinical data. The research support policies of EPA also have not encouraged greater participation, since the Agency has been reluctant to support basic research programs for more than two years. Most basic research programs require one year for staffing and start-up and at least two years for experimentation.

It has also been the stated policy of EPA to discourage the purchase of specialized equipment through research grants. Air pollution research requires, however, expensive inhalation facilities which are in short supply. Capital equipment in universities is declining with the overall reluctance of federal agencies to support equipment purchases. The net result is a general decline in the quality of U.S. science. The problem of research equipment has been stated clearly by Dr. Lewis M. Branscomb, Chief Scientist of International Business Machines Corporation, in a recent issue of Science (L. M. Branscomb. Research Equipment Acquisition. Science 212: 877, 1981). Recently, I helped to implement a new toxicology program in West Germany, whose economy is highly dependent on chemical manufacture. The federal government of West Germany recognized the need for capital expenditures in equipment and the importance of toxicology through an aggressive program of support of these needs and the recruitment of American scientists as advisors through the Humboldt Foundation. I urge the Congress to encourage the retooling of American laboratories to maintain our acknowledged supremacy in science.

Only by stabilization of the research support program and emphasis on basic mechanisms will EPA eventually solve its long-term problems. In the interim, EPA will have to rely on more problem-oriented research. Such problem-oriented research needs stronger scientific direction and less direction by regulators. The present "Research Committee" approach is not meeting the needs of EPA. Some problems will not be addressed satisfactorily from the regulators' viewpoint by a stronger direction towards basic research for at least five years. Nonetheless, the results will be more useful to the public in the long run and less costly.

In sum, while I support the unsolicited peer review grants program of EPA, it should not be conducted at the expense of the essential directed research program as now appears to be the case. For example, solicited research in oxidizing air pollutant toxicology is suffering. The present grants program is developing slowly, but adequately. The grants program could be significantly accelerated by EPA through a clearer statement of the information needs of EPA, an improved grant application form, and a demonstration to the scientific community that EPA intends to continue the long-term support of the program. The Congress can aid EPA in this effort by independent financial support of the grants program and by continued support of the directed research program. I am realistic enough to recognize that major initiatives are not likely given the crisis in government expenditures, but I suggest that the alternative of a general diminution of research support by EPA will delay further the time at which EPA has a sufficient fund of knowledge to make more mature judgments. I would also urge that the Congress direct other agencies supporting air pollution toxicology to increase their emphasis in this area to stimulate the recruitment of the finest scientific talent to this important area of research. A clear statement of the need for air pollution health effects research should also be made with the reauthorization of the Clean Air Act.

5. Manpower Needs in Air Pollution Research

Toxicology is a difficult science to master. It is a graduate level study requiring a wide background in the more fundamental sciences. To date, toxicology is best taught as a post-graduate discipline and by postdoctoral research training. Such training is expensive, time consuming, and difficult. Toxicology is one profession particularly identified by the National Academy of Sciences Manpower Survey as being in short supply. Postdoctoral training of candidates already trained in other scientific disciplines is an efficient way of meeting the short-term manpower needs in toxicology, but the long-term solution is the development of toxicology training as a specialized discipline as encouraged by the Society of Toxicology. Because of the graduate level requirement, training in toxicology is expensive and beyond the means of many students. The demands for toxicology research are increasing as our awareness of the impact of chemicals on human health becomes more defined. The total number of toxicologists needed may be much smaller than originally anticipated, but certainly more than the present programs will allow. This is particularly true in air pollution research. EPA has not supported a training effort for toxicologists, and the government has relied upon the NIEHS program. A small effort has been made by private sources such as the Chemical Industries Institute of Toxicology, the Mallinkrodt Foundation, and a few individual companies, but maintenance of a viable training program will be essential to high quality future research. The alternative will be the utilization of those not trained in toxicology. The need for certification of toxicologists by learned societies speaks to a recognized need by the profession to regulate the quality of the practice of toxicology and to discourage those not adequately trained. Toxicology training programs are embryonic and need the support of the Congress, either through the Clean Air Act and EPA or through other federal agencies such as the National Institutes of Health or the National Science Foundation.

Thank you for the opportunity to express my views. I will be happy to respond to your questions. I hope that I have made it clear that basic, as well as applied, research is essential for thoughtful decisions in maintaining and improving our air quality. In our search for less costly means of attaining clean air, we should not lose sight of the demonstration by animal and human exposures that polluted air is harmful. In this context, then, we are substituting in our minds dollars for disease when we speak of air pollution regulation benefits. As long as our air remains polluted, disease is still being caused by air pollution.

Mr. **Brown**. Dr. Frank?

Dr. **Frank**. Thank you for the opportunity to participate in this hearing. I have a fairly brief statement. I will skip over the first page and get on to sketching briefly the findings and recommendations of the National Commission on Air Quality that I think appear relevant to your deliberations.

Implicit in the Commission's report is the view that the Federal Government should continue to play the major role in sponsoring this health effects research. At this time, the other important source of support is industry. I do not have explicit information at hand, but it is my impression, based in part on my activities as an industrial consultant, that industry's support of research on the health effects of air pollutants has during the past few years been increasing significantly relative to that of the Federal Government.

The reason is clear. Industry has a large stake in the outcome of such research, and it believes that its interests, and perhaps those of society in general, have not been adequately served through federally supported research. Certainly, industry's contribution in the field has been welcomed by the investigative community.

But industrial support is subject to uncertainty and fluctuation, perhaps even more so than is Federal support. And I would suggest that society would be best served if the Government remained the chief sponsor. I think then it's most likely to be stable and unfettered.

The Commission examined several constraints that have limited EPA's ability to conduct or manage biomedical research. It was apparent that EPA's performance in this regard has varied depending on the nature of the research attempted.

I thought it would be useful, therefore, to distinguish among the major types of research engaged in by EPA. You could say they are three in number: basic, anticipatory, and applied.

The basic research, as you might expect, provides an understanding or explanation of the phenomenon in question. It has little direct impact on regulatory decision.

So you might predict it would be least favorably treated in the atmosphere today, and you are correct.

Anticipatory research provides prior knowledge that may be used to prevent or avoid hazards. Unfortunately, it is usually easier to obtain support to identify the cause of established illness than to get information useful in preventing.

Applied research, which in great measure is confirmatory in nature, emphasizes dose-response or dose-effects relations. It is the soul of regulatory decisionmaking.

I might add it is also the type of research that appeals mostly to industry.

Any of these three forms of research, whether involving isolated cells, whole animals or human subjects, may be short or long term in duration. They complement each other, although one may take precedence in importance over the others with respect to one particular regulatory decision.

For example, NCAQ's studies suggest that the results of short-term studies of human volunteers with asthma, conducted in the controlled laboratory situation, may play a crucial role in the decision regarding the 24-hour ambient air quality standard for sulfur dioxide; whereas by contrast, the results of long-term exposure of animals to ozone have raised questions, concerns about the ozone standard that cannot be resolved at present by either laboratory or epidemiological studies on humans.

NCAQ found that while all three forms of research are vital to the understanding and control of both regulated and as yet unregulated pollutants, the Agency's research program must of necessity respond to immediate regulatory needs.

It therefore favors short-term research, at the expense of long term, basic, and anticipatory research. The Environmental Research, Development, and Demonstration Act of 1978 was designed to prevent this imbalance.

That is, it mandated that 15 percent of all research funds at EPA be assigned to long-term studies. But, in fact, there has been no appreciable movement by the Agency toward this end.

Instead, NCAQ found that environmental emergencies, such as occurred at Three Mile Island and Love Canal, forced major shifts in allocations of personnel and funds. As a consequence, other research at EPA was disrupted. Since funds diverted from planned or ongoing programs often cannot be recovered, permanent interruption of studies is inevitable.

For this reason, NCAQ recommended that a fund be appropriated for EPA, apart from the regular research budget, which was to be used solely for research on environmental emergencies.

The major research program at EPA that has borne the greatest criticism is epidemiology. This criticism is focused on the CHESS report, a compendium of studies in several communities spread across the Nation, that was released by EPA in 1974.

Ultimately, EPA's ability to conduct credible scientific research was called into question. And the same question has been reinforced fully by some of the difficulties encountered at the Love Canal, associated with other agencies. In our judgment EPA has within the past few years responded to much of this criticism and taken steps to insure both the quality of its research planning and execution and the analysis of results. It now relies on formal research committees to establish priorities. I notice that Dr. Menzel feels that thus far these committees have contributed little.

It is my impression that they have improved the system in establishing priorities, in helping to establish research strategies. They have not found the secret to insuring stability but that is not, I think, one of their functions.

EPA has also instituted an independent peer review system to examine all proposals for extramural research. It has shifted epidemiological research exclusively to the extramural program, and in the process virtually dismantled the original intramural component.

I think they had to do this in the face of defeat and it was a reasonable move to make and I think if anything insofar as they can sustain the extramural epidemiological program, I think it is all to the good. It is attempting to establish long-term cooperative agreements with established research centers outside of Government at least in part to help this.

And there is an effort underway to increase involvement by the Science Advisory Board, an independent body of scientists chosen by the Administrator of EPA, in the review process of intramural research, which requires the most examination.

If these efforts are pursued diligently, it should be possible to insure pertinent, scientifically credible research within EPA.

Thank you, Mr. Chairman and members of the committee, for your kind attention.

[The prepared statement of Dr. Frank follows:]

PREPARED STATEMENT OF ROBERT FRANK, M.D., UNIVERSITY OF WASHINGTON

Mr. Chairman, thank you for the opportunity to participate in this hearing. I am Robert Frank, M.D., Professor of Environmental Health at the University of Washington. For 17 months, until May 1st of this year, I was on leave-of-absence from the University working for the National Commission on Air Quality (NCAQ) as Chief of its Division of Health and Environmental Assessment. I have had a long-standing involvement in research on the effects of air pollutants on the lung, have collaborated on several reports on this subject sponsored by the National Academy of Sciences, including those on Airborne Particulates and Sulfur Oxides, have participated in the preparation and review of the Environmental Protection Agency's (EPA) criteria documents on ozone and combined sulfur oxides-total suspended particulates, and have been consultant both to the Science Advisory Board and Office of Research and Development at EPA. Currently, and for a short interval, I am a consultant to the Electric Power Research Institute (EPRI), assisting the Institute with its biomedical research program.

I would like to relate briefly the findings and recommendations of NCAQ that appear relevant to your deliberations, while adding a few personal comments. The focus of these remarks is on research designed to assist regulatory decision.

The following may be taken as truisms:

- that regulatory decisions have wide-ranging, often powerful consequences for society;
- that such decisions should therefore be based on credible scientific and technical information;

- that the regulator must nonetheless be prepared to make decisions in the face of incomplete or imperfect information;
- that the quest for information useful to the regulatory process is essentially unending.

Implicit in the Commission's report is the view that the federal government should continue to play the major role in sponsoring this research. At this time the other important source of support is industry. I do not have explicit information at hand, but it is my impression, based in part on my activities as an industrial consultant, that industry's support of research on the health effects of air pollutants has during the past few years been increasing relative to that of the federal government. The reason is clear. Industry has a large stake in the outcome of such research, and it believes that its interests, and those of society in general, have not been adequately served through federally supported research. Certainly, industry's contribution has been welcomed by the investigative community. But industrial support is subject to uncertainty and fluctuation, perhaps more so than is federal support. I would suggest that society would be best served if the government remained the chief sponsor. Governmental support, among all possible varieties, is most likely to be stable and unfettered.

The Commission examined several constraints that have limited EPA's ability to conduct or manage biomedical research. It was apparent that EPA's performance has varied depending on the nature of the research attempted. It would be useful, therefore, to distinguish among the major types of research engaged in by EPA. They are three in number: basic, anticipatory, and applied.

- Basic research provides an understanding or explanation of the phenomenon in question. It has little direct impact on regulatory decision.
- Anticipatory research provides prior knowledge that may be used to prevent or avoid hazards. Unfortunately, it is usually easier to obtain support to identify the cause of established illness than to prevent the illness.
- Applied research, which in great measure is confirmatory in nature, emphasizes dose-response (or dose-effects) relations. It is the soul of regulatory decision-making.

Any of these three forms of research, whether involving isolated cells, whole animals or human subjects, may be short- or long-term in duration. They complement each other, although one may take precedence in importance over the others with respect to a particular regulatory decision. For example, NCAQ's studies suggest that the results of short-term studies of human volunteers with asthma, conducted in the laboratory, may play a crucial role in the decision regarding the 24-hour ambient air quality standard for sulfur dioxide; whereas the results of long-term exposures of animals to ozone have raised concerns about the ozone standard that cannot be resolved at present by either laboratory or epidemiological studies on humans.

was called into question.* EPA has within the past few years responded to much of this criticism and taken steps to ensure both the quality of its research planning and execution and the analysis of results. It now relies on formal research committees to establish priorities. It has instituted an independent peer review system to examine all proposals for extramural research. It has shifted epidemiological research exclusively to the extramural program, and in the process virtually dismantled the original intramural component. It is attempting to establish long-term cooperative agreements with established research centers outside of government. There is an effort underway to increase involvement by the Science Advisory Board, an independent body of scientists chosen by the Administrator of EPA, in the review process of intramural research. If these efforts are pursued diligently, it should be possible to ensure pertinent, scientifically credible research within EPA.

Thank you, Mr. Chairman and members of the Committee, for your kind attention.

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*This criticism has had profound effects on the Agency's ability to recruit and retain scientists of high caliber. Other disincentives to scientists within EPA are enumerated in the reports cited.

Mr. **Brown**. Thank you very much. Do you have any questions, Mr. Scheuer?

Mr. **Scheuer**. I do, but I prefer to follow your questions.

Mr. **Brown**. Mr. Dunn?

Mr. **Dunn**. Go ahead, Mr. Chairman.

Mr. **Brown**. Dr. Frank, I was interested in all of your comments, but particularly in your reference to the CHESS studies as examples of epidemiological research by an agency. As you probably recall, this subcommittee had devoted considerable effort to looking at that program several years ago. I note your favorable comment with regard to the shift in epidemiological research to extramural contracts with an emphasis on long-term programs.

I think all of the witnesses have indicated the need for this greater emphasis on long-term contracts. The question that I have is whether the quality of a good part of the EPA's research would not be improved if within the framework of a fairly comprehensive research plan, we could identify the major areas that required attention over a period of years and establish either contracts or the designation of centers of research at some outstanding institution to carry on a particular program within the framework of this overall research program. EPA would, of course, initiate, review, and update periodically as needed, such a program. Would this model be a superior way to accomplish the research goals of the Agency?

Dr. **Frank**. I think the answer to that question depends upon the nature of the research. With respect to short-term research, EPA has shown that it can conduct useful research in terms of its being relevant and timely for regulatory needs.

Where EPA has fallen down is in the long-term research approach, a prime example being epidemiology. I am in favor of the Agency's increased reliance on extramural programs in which EPA retains a management role, but the research is conducted mostly in academic centers.

Mr. **Brown**. I was trying to extrapolate from that conclusion to a broader conclusion for the conduct of other kinds of long-term research. Most of the basic research that the Agency is doing on health effects particularly is long term in its nature. We are dealing with problems that we have sought solutions to for many years, and still don't have solutions in most cases. We need to ally ourselves with permanent research institutions that could take this task on as a long-term commitment.

Dr. **Frank**. I would like to defend in principle the opportunity for EPA to participate in long-term research that has basic and anticipatory objectives in addition to applied objectives. When such research is conducted by an institution, it generally insures the presence of good scientists, for they are the ones attracted by basic research.

They in turn feed the entire environment. If EPA were to be simply a management regulatory agency, I think it would lose a lot of its ability to judge issues scientifically. I might add that we now have a system in operation which feeds back to EPA information about needed research. It is inherent in the development of criteria documents.

If there is one beneficial result that comes from the criteria document, it is the explicit identification of work that remains to be done to improve one's ability to regulate a specific pollutant.

Mr. **Brown**. Dr. Lave, you brought up in your statement similar concerns about the management of EPA's research program, indicating that you felt a larger part of it probably could be done extramurally, if I recall your statement correctly. My impression was that a majority of the EPA's research now, perhaps a narrow majority, was also being done through grants and contracts with extramural agencies. Your feeling is that it needs to go still further in this direction, am I correct?

Dr. **Lave**. Yes, and if I may also comment briefly on the question you asked Dr. Frank. I guess that you always have one of these difficult tradeoffs where you are thinking about establishing a center, and making a long-term commitment to that center versus running a competitive grant program, where all of the money is up for grabs every time.

On balance I prefer the latter way of doing business. I prefer to have scientists try out their ideas on the study section out to allocate the money competitively. As I have gone through a couple of rounds of looking what happens when you try to establish centers, all sorts of nonscientific criteria come in: Whose district the particular center happens to be in begins to be relevant, or what kind of a university, or all sorts of other criteria. In a competitive grants program, those questions cannot infringe as much.

One of the problems in the past has often been that the duration of any grant was limited to 1 year or 2 or 3 on the outside, and that is simply impossible for certain kinds of research, especially epidemiology.

To get back to your other question, yes, I think that EPA's moneys could be better spent by having more of those be extramural, but at the same time, I think Bob Frank's statement was one that I would want to endorse and did in my statement, namely, there has to be a hardcore of good scientists around the Agency and the only way you can get that is offering intramural research.

Mr. **Brown**. I have given consideration to the desirability of seeking a more broadly dispersed and decentralized structure of research, on general problems of the environment that include everything from monitoring to health effects and technology. The Federal Government feels that it needs to exercise control over programs it pays for. What we need is a widely dispersed system researching a range of problems that may be of concern locally or regionally or nationally, as the case may be, but in which we are getting a range of input.

Now, the question is how do you harness the research facilities that exist in this country, and we have a great abundance of capable researchers, into a framework of this decentralized nature. I am not convinced that relying entirely on Federal grants is the way to do this. The Nation needs a comprehensive research framework, perhaps the criteria documents would be the basis for this, indicating the questions that you need answers to.

With this framework and some minimal incentive we could get research performance at leading universities or other research institutions all involved in a national program to solve these problems.

I think of this as a way of involving people in the learning of science, of motivating them, for example, to want to do a better job of monitoring their own environmental surroundings so that they can understand the forces that impinge upon their health and the quality of the region. Is this an impossible dream?

Dr. LAVE. It had better not be. One of the problems in environmental regulation is the adversarial system. We have Dr. X testifying on behalf of EPA's science and Dr. Y testifying on the basis of industry science. It is all the same science, all of the same basic underlying facts, but the adversarial nature of the process amplifies uncertainties and contradictions.

That adversarial framework does not serve society well. We need to begin by finding the largest area scientists that agree and then attempt to get agreement on the nature of the uncertainty. What is served by have scientists going off and testifying with absolute assurance on those areas of science which are uncertain at the moment?

The kind of framework you are talking about has been attempted in several ways. One could think of cooperative research centers jointly financed by government and by industry or by Federal and State Government. Such centers are worth more emphasis than they have received in the past. They are going to resolve all of the uncertainties because the science is still largely uncertain. But if we could get agreement about what it is that we know and what is still uncertain, I think we could end a good many of these fiascos at regulatory hearings and in the press where scientists make each other look like fools.

Mr. BROWN. Let me ask just one additional question. I have been concerned about the reduction in the research budget of the EPA in the current fiscal year. I am not heartbroken at the fact that research has to take some share of the overall reductions but it still seems to me that what we really need if we are going to save this country tremendous sums from regulatory excesses or from the adverse effects upon the health and environment from pollution, is more research not less, and that it is a cost effective thing to do. Yet this is difficult to quantify.

Do any or all of you gentlemen have any reaction as to how we might determine the political desirability of reducing the funds for environmental research and development? I am asking you to comment upon what is basically a political question, but nevertheless I would value your views on that.

Dr. LAVE. Can I go first? Then you gentlemen could say something sensible.

We could afford to reduce the total budget of EPA, and still enhance the agency. Literally vast amounts of money have been spent on short-term fire drills which produce nothing. And if we were to save those funds, have fewer fire drills, there would be more resources, especially human resources, to work on the real problems.

That takes a different public attitude than, for example, seems to have come from Love Canal. It is one that says the world is not burning down right now. That doesn't mean that there aren't important concerns, but flailing about distracts us from the correct actions.

The second way to try to answer your question is to pose the question back to you. What would it be worth to the Congress if we could narrow the range of uncertainty about, for example, the health effects of sulfur oxides by a factor of 10 over what they are right now? Would that help either the EPA Administrator or the Congress make better decisions?

As long as the Clean Air Act amendments say that the Administrator has to require the best available control technology, then more certainly wouldn't help at all. They might help Congress a little bit in trying to decide whether to clip EPA's wings or to change the legislation, but they are not going to help the Administrator.

The basic case I would make is that, regulations are going to require expenditures of billions of dollars per year, society demands we have a stronger basis for making those judgments.

When we start looking at quantifying the benefits of pollution abatement, at what it is worth to society to spend these billions of dollars, then the value of this research is apparent.

Mr. BROWN. Dr. Menzel?

Mr. MENZEL. Well, I would like to sort of look at it from a little different viewpoint and suggest to you that—without insulting you—we are all politicians in our little field, that is science. So we are politicians of science in the sense that we are here to express some ideas of what needs to be done. There are certain kinds of problems inherent in the politics of science as regards this overall problem of the environment.

Scientists have not embraced problems in the environment with a great deal of enthusiasm. They have viewed them as being too applied and empiric to be of academic interest. And the leading scientists in the United States as judged by other kinds of yardsticks, such as national awards, Nobel Prizes and membership in the National Academy of Sciences, simply aren't participating in this.

So, there is a lot of skepticism and one wonders about your dream of drawing together everyone into participation in environmental concerns. I think that this stems in part from three problems: First, what Dr. Lave has said is absolutely true. EPA has invested enormous sums of money in fire drills to benefit no one.

Second, its philosophy about how to start up scientific endeavors has been rather naive and an engineering approach—that's to look for people who already have facilities, who already are engaged in this research, rather than for new ideas.

And, third, it's really not attempted to formulate any kind of cooperative effort aside from this recently launched Institute of Health Effects, which one must admit is a very broad title for something dealing only with auto emissions.

So I would say that if one were to look at the total effort that is being spent on environmental research and contrast that with the effort being spent in other areas of science, I think it is disproportionately low. To make a case for that, though, is very difficult, at this juncture because people have gotten a very slanted perception of toxicology, which is what we are really talking about.

People think that every day in the newspaper they will read that they can't drink orange juice, or they can't drink coffee, or they can't drink tea or water because it contains some toxic substance. I think this is a problem; that toxicologists have not engaged in any kind of a general educational effort.

How to go about that kind of an educational effort has been proving to be very difficult indeed. I have no real wise words to say about how to do that, except that I think the best long-term solution still remains in the definition of the basic and fundamental properties that are involved in the toxicity of these compounds and to clarify these facts better.

I don't agree with the concept of going out and having all of the effort exclusively in centers of specialized effort or cooperative research centers, because my experience with NIH review panels is this has not necessarily been the best science. This has not allowed competition among scientists to work its wiles.

But I really must emphasize this problem of capital equipment. There are a very limited number of universities and institutes in the United States where you can expect to find the capital resources in equipment that will carry out research this effectively.

Mr. **Brown**. Do you have any comments, Dr. Frank?

Dr. **Frank**. Several, and in part I think they are takeoffs on comments made by the two fellows to my right.

First of all, we are dealing with what I would call "regulatory science." As Les Lave said a little while ago, this is essentially equivalent to adversarial science, and it makes certain demands. These demands are not necessarily encountered, for example, at NIH. EPA has had ample experience with these special demands.

EPA was rather naive 10 years ago, but so was the entire scientific world, which ultimately became involved in regulatory science. There has been a lot of improvement arising out of painful experience and an evolution of the process.

I think at the moment that EPA is able, within reasonable limits, to perform research that is relevant to regulatory research needs and to do it expeditiously. The big concern lies in the quality of the work.

I might add that although EPA may be said to have spent money unwisely in fire drills, we have to realize that EPA is subject to enormous political and public pressure. At times it may start on a course of action which perhaps the more balanced minds within EPA would not choose to take but they feel they must yield to such pressures. So it isn't as if they are doing this willfully.

And without going into a listing of what might improve the quality of the research, I think we come down ultimately to the largest chink in the armor of EPA; an inability to recruit and retain good scientists. I think some steps are being taken to improve this situation, but they may not be adequate. There isn't any doubt at all but that EPA could have accomplished whatever it has with less money. I think this would be generally true of most institutions, however.

My own feeling is that it has been learning, perhaps painfully and at great cost. I'll leave it at that.

Mr. **Brown**. Gentlemen?

Mr. DUNN. Dr. Frank, in your testimony you discussed some of these outside research centers that the chairman has been talking about as an ideal scenario. Has EPA actually established any such policy? Do we have any of these centers that will be established in the near-term? If so, I would like any specifics of how they are to be established.

Dr. FRANK. There are two centers I can speak to which are in their initial phases. One is at the University of Pittsburgh, and its charge is essentially to do epidemiology with initial emphasis on fine particulate matter. This is, I would say, highly relevant research.

In my own judgment, there is great concern over whether there is a need for a fine particulate standard. I don't think there is enough scientific evidence at the moment to support such a standard. The hope is that before the review process is completed 5 years down the line we will have good epidemiological evidence providing insight into the answer for that.

This cooperative center at the University of Pittsburgh should contribute to that.

Another study which should contribute is the Harvard study which EPA is helping to support, another example of turning toward extramural research for areas which are best handled extramurally.

Mr. DUNN. Are they given some guidelines or requirements of what is expected to come out of this research, or is this basic research?

Dr. FRANK. No; this is not basic reseach and I don't want to be overselling this, but here are some of the steps being taken to insure its relevance. There is a committee, which includes people that have been chosen both by EPA and the University of Pittsburgh who are thought to be knowledgeable in this field, who are contributing in the planning stage.

EPA itself is very actively involved in the planning stage. So it is not as if we are dealing with a cooperative center which, having gotten its money, can now go off on its own.

I think another such center, which should provide useful information through collaboration is at the University of North Carolina. There is going to be, I think, intimate involvement of the University faculty in the human clinical facility that EPA has. This is an extraordinary resource which has provided very little useful information to date.

Mr. DUNN. In, say, the next 2 years, what is EPA's goal, in a percentage, if you will, of in-house research versus grants or these special centers? Do you have any feel for that or not?

Dr. FRANK. I looked at some of the information about the assignment of moneys to intramural as against extramural research over the past few years, and generally the intramural research on health effects has been awarded approximately 40 to 50 percent of the total and the extramural research 50 to 60 percent.

I think now with the shift away from any real plan to conduct intramural epidemiological research that there will be a further shift toward greater reliance in assigned moneys to the extramural program.

Mr. BROWN. Mr. Scheuer?

Mr. SCHEUER. Thank you, Mr. Chairman. Time is pressing. This has been an extraordinarily interesting panel, and I wish to congratulate and thank the members who have given us this testimony. I would like to ask unanimous consent that the members be allowed to submit questions in writing.

Mr. BROWN. Without objection and with the cooperation of the witnesses, of course.

Mr. SCHEUER. We hope to get that. I have a number of questions to ask all of you that flow from your testimony, but time simply doesn't permit. Since you are a self-described politician-scientist, I would like to ask you a couple of applied and empiric questions, to use the phrase that came rolling over the hills here, on two here-and-now questions that the Congress is facing. The first is on the Clean Air Act. We are redoing the Clean Air Act. Forgive me if I ask you a short-term question.

I would like to have your comments and suggestions as to the kind of fine tuning and recasting that you would suggest for the Clean Air Act. Implicit in your testimony, there have been some suggestions. I would be very grateful if you could address the simple question of the Clean Air Act and tell us the kinds of adjustments that you would suggest.

The second question bears on the question of acid rain, and particularly our relations with Canada. I was in England, France, and Germany a couple of weeks ago with Congressman Udall, and we heard a great deal about acid rain there. We know how exercised the Scandinavians are. A group of us are going to Halifax this weekend to meet with the Canadians and their parliamentarians on the question of acid rain.

So my second question to all of you is, from the point of view of research, what should we be doing to address the question of acid rain, both as between ourselves and the Canadians and, second, between the Middle West in our country and the Canadians? Is there any need or usefulness in thinking about some kind of an improved or slightly more advanced global environmental monitoring system to give us more information on how we can help solve in the United States, the Canadian problems?

The Canadian Minister of Environment told us that America contributes more than 50 percent of all of the fluids that constitute Canada's acid rain and acid snow problem. It collects in the snow and come spring, an enormous engorgement takes place. It has a devastating effect.

We are poisoning our own lakes, over 200 of our Adirondacks are atrophic. And I come from New York, and it hurts to think about it. It's poisoned our diplomacy with Canada.

I would be happy to have you respond in writing, if you prefer, with the few minutes that remain. First, what kind of fine tuning do you recommend for the Clean Air Act; and second, how should we organize our R. & D. to be more effective than it is now in the question of acid rain?

Dr. LAVE. The first is, I think that fine tuning is the right phrase for what the Congress ought to be doing on their Clean Air Act. It should not be taking a meat ax.

As distinct from the 1970's Earth Day in 1969, 1981 will be a time when we will give much more emphasis to efficiency and less to rhetoric and to making noble statements about our future.

When we are thinking about the reauthorization of the Clean Air Act, those have to be the main themes. I confess I am an economist, but I think if we look back at what we have accomplished to date, we could have done it with less controversy and we could have done it much cheaper; that is what we are going to have to look for in the 1980's.

We should not back off our goals in the environmental area, but we have to learn how to achieve those goals with less controversy, with less wasted resources, with less cost than we have in the past.

I think that one way of doing that is basically to get away from technology-based standards and rhetoric and region that benefits be roughly commensurate with costs. I am not in favor of the Executive Order 12291, which requires stringent benefit cost analysis. That makes no sense to me.

Acid rain is a classic national problem, involving long distance transport. It's not something that can be handled locally.

We have to know more about the source of the emissions than we know now. I think there is a lot of monitoring that is going to have to go on in that area.

Dr. MENZEL. Well, basically, I agree with what Dr. Lave has said here, that the Clean Air Act needs to be fine tuned rather than dismembered. I would say that what you are asking is very similar to the experience I just had last year.

At the invitation of the German Government, I was in West Germany to deal with the startup of their toxicology program, and how they would in fact deal with the overall problem.

They have a very chemically oriented economy, and so this is very important to them. I think that one point—one particular area of fine tuning that needs important addressing to get on with the job—is how the criteria documents are put together.

The criteria documents are put together in such a contentious and electrified atmosphere that it's very difficult to get people, aside from confessed politicians such as myself, to put their foot in their mouths and say something definitive.

We end up with all of these weasel-worded statements that are useless to a lot of people and don't resolve the problem.

I would suggest you give very serious thought to that and perhaps, with your permission, I might provide you with my efforts in that area.

With regard to the question of cooperation, indeed I think toxicology has been treated as being within national geographic boundaries.

My first effort was distribution of DDT in the oceans, and I found it was in the Antarctic and Arctic and all over the Pacific Basin. So it really isn't a national problem; it's in fact an international problem.

However, since it involves great economic effects, I think this is a very, very difficult area and an area in which we should proceed with very great circumspection. I am not in favor of launching forth, even with our good friends in Canada, an effort without some very careful considerations as to what the long-term implications might be.

Mr. **Scheuer**. How would you organize that long-term research program?

Dr. **Menzel**. First, let me say that the Canadians are not without their own resources. They do have a very fine scientific academy in Canada, so I would suggest they are not supporting their end of the business as much as they should be.

Very minimal effort has gone to supporting research in Canada, so I think the Canadians should look to their own job in the first place. The second way to go about it is that I served on a United States-Canadian cooperative business board organized in the Pacific Northwest at one point, in which we had a research arm. That was a relatively effective method of going about carrying out collaborative research efforts.

I really think, though, if you engage in some long-term commitment to a massive monitoring system, this represents a very dangerous thing to do in certain regards. I think one needs to think about this very carefully.

Mr. **Scheuer**. Would you elaborate? Dangerous in what respect?

Dr. **Menzel**. Suppose in fact, it really is true, and I don't know that it is, but suppose it were true that 50 to 90 percent, some very large fraction, the majority of the pollution came from the United States and was translocated to Canada.

Then perhaps we would be in the embarrassing situation of having to go to very stringent regulations, in order to reduce that, and the cost would be essentially borne by the industry in the United States.

And the consequent economic impact would flow from that. I wonder if, in fact, that would be the proper resolution in the long run? Because although I agree that this is an international problem, I do not, in my view of the current evidence that I have read about acid precipitation, I am not sold on the figures that have been bandied about.

I think we don't have enough information to come down on a number and even if we did, I think that we would have to be very careful about the facts to be sure that the consequences that would flow from it would be recognized. That is sort of coming around to what I said in the beginning, I guess.

Mr. **Scheuer**. I am a little astonished to hear a scientist say he's afraid to do research because the results that would be adduced would lead to some trouble on some questions that have to be faced.

It seems to me that facts and knowledge are always relevant and can only help us unless you want to hide from one's national responsibilities. As a New Yorker, I want to know where that stuff comes from. I am almost in the same situation as the Canadians.

This stuff comes from the Middle West, and it seems to me that we have to provide some kind of responsibility for regions that are emitting pollutants, whether they are poisoning other regions in the United States or whether these pollutants are being transported across borders.

It seems to me that for the sake of elemental serenity and decency in our relations with Canada, it seems a necessary precondition of coping with the problem would be knowing more about it.

Dr. **Menzel**. Perhaps I misstated or again didn't communicate properly. I am not living in the delusion that ignorance is bliss with regard to environmental pollution, because after all, that is my entire career.

I have a letter which I have saved from a scientific review group at NIH when I applied for money to study DDT distribution in the ocean, which they told me was technically impossible and was of little consequence should that information be derived.

So, I think I am on the record as having proceeded with it. Now, what I was really alluding to was my very brief experience in dealing with this problem in Europe. Because there are vested national interests in various kinds of activities at times—a program could be evolved that would really be self-serving to one national interest and not to another.

That is precisely what I meant. That if, in fact, one were to engage in such a long-term project and to monitor distribution, it should be done in a very circumspect manner and in such a manner that it would represent a rational and complete statement of the facts. Certainly I would agree with you, Mr. Chairman, that the relationship between the United States and Canada does not deserve this poisoning from this issue of acid precipitation.

It needs to be resolved. But I think it's a very big problem and one that I would not wish the United States to unilaterally rush into without very careful consideration.

That is my feelings.

Mr. **Scheuer**. Could we hear briefly from you, Dr. Frank?

Dr. **Frank**. If the question is whether there should be some national or international monitoring network to provide new information, presumably related to acid deposition and acid rain, which might be useful in future regulatory decisions, then I would say this is the type of information which should be obtained through research rather than through any national monitoring network.

The reason for that goes back to the experience that we have had with EPA's national air monitoring network. Critics are still questioning whether EPA can monitor accurately enough for regulatory decision something like fine particulate matter.

I think there is underway several research programs, rather large, and they also involve Canada as well as the United States, on acid deposition and acid rain. And that they have learned now, the questions to ask in terms of research, and they are in the process of accumulating credible and useful data.

Mr. **Scheuer**. Who is they? I didn't quite get that.

Dr. **Frank**. I can't give you the exact name of the group, but I think the lead element in the group is NOAA, and it involves several agencies.

I think, too, there is collaboration between Canada and the United States, designed to find out what is happening not only to the pH of lake waters, but to the buffering capacity as well, with the specific intention of relating such changes, if and as they occur, to possible sources.

I think we have a reasonably safe lead time in which to work. Acid deposition is ultimately related to emission rate: If we can project that for the next several years, in terms of whatever policy we have with respect to fossil fuel consumption, there won't be any significant increase in SO_x emissions and NO_x emissions, we can feel reasonably safe that there is not going to be a significant worsening of the acid rain, acid deposition problem.

The sort of changes or fine tuning or anything else you care to characterize it as that will be needed in the Clean Air Act is to bring it up to date in terms of recognizing, and Les Lave said it hasn't, that in fact long-range transport is a real problem which was really not recognized when the Clean Air Act and its amendment were instituted and acid deposition is one manifestation.

This will have to be attacked. It's a highly contentious field. This involves not only international hard feelings but interstate hard feelings as well. There are a number of other fine tuning elements that I won't go into.

I would be willing to answer them, specifically regarding the process of standard setting, which I think is going to be quite contentious as well.

Thank you.

Mr. Scheuer. Thank you very much.

Mr. Brown. Thank you all, gentlemen, and if we may have your cooperation in responding to any additional question, we would appreciate it.

Our next panel this afternoon will deal with the subject of control, monitoring, and precombustion technology, and we have three distinguished members on this panel: Dr. James Mahoney, senior vice president of ERT, Inc., Mr. Tobias Anthony, director for business development and Washington affairs, Research-Cottrell, and Sidney Orem, executive director of the Industrial Gas Cleaning Institute. If you gentlemen would take your seats.

STATEMENTS OF DR. JAMES MAHONEY, SENIOR VICE PRESIDENT, ERT, INC.; TOBIAS ANTHONY, DIRECTOR, BUSINESS DEVELOPMENT AND WASHINGTON AFFAIRS, RESEARCH-COTTRELL; AND SIDNEY OREM, EXECUTIVE DIRECTOR, INDUSTRIAL GAS CLEANING INSTITUTE

Mr. Anthony. Thank you, Mr. Chairman.

I would like to make two essential points today regarding long-term R. & D. for air pollution control technologies needed to burn coal cleanly. I would like to emphasize the subject of burning coal since that is the area where most of the air pollution control technology has been directed for the past 30 or 40 years.

First, the Clean Air Act makes it unwise and unrealistic for the private sector to invest in long-term R. & D. exclusively. Second, burning coal cleanly and economically in the future will require the development of technologies in the combustion or precombustion phases.

Mr. Brown. You go right ahead. We welcome Dr. Mahoney, but because he was 3 minutes late, he will have to line up behind the other witnesses.

Mr. Mahoney. Thank you, I apologize.

Mr. ANTHONY. I would like to repeat the second point. Burning coal cleanly and economically in the future will require technologies in combustion and precombustion phases. Federal funds will be needed for R. & D. in those latter two phases.

The Clean Air Acts of 1970 and 1977 tended to discourage private investment in R. & D. even though those acts created a billion dollar market. There are several reasons for this. One, the 1977 act calls for review of new standards every 4 years. This means that when the act was changed in 1977, the resulting standards made limestone scrubbers for low-sulfur coal application obsolete. Two, the EPA has forced the funds for developmental technologies to be used to optimize new performance standards since those must be based on technology. That caused the EPA to put competitors into business. No one in the private sector would invest his money under those circumstances.

Three, since it takes some 10 to 12 years to bring a technology from test tube to commercial sale, and EPA's rules could change every 4 years, the suspicion is the payback period would never be realized. These are the primary reasons our industry acquired foreign technologies or depends on Federal funds to finance the early high-risk periods of research.

In order for the Federal Government to get out of the R. & D. business, which is of interest to some people, standards would have to be frozen for at least 10 years. I am not sure at what level, but then this huge dollar market would be predictable enough for industry to develop higher efficiency and more cost-effective systems for whichever phases of combustion makes the most sense.

This might be an acceptable step to take for particulate and sulfur oxide control where 95- to 99-percent reductions are already possible. I cannot address the environmental consequences of such an action.

That brings me to the next point. Burning coal cleanly means reducing criteria pollutants during any phase; namely, postcombustion, combustion, and precombustion. Historically, we focused on postcombustion cleanup, but it makes more economic sense to clean up during or before combustion, except for further development in the postcombustion cleanup of combination of particulates, NO_x and SO_x in one system. The reason for this approach is that postcombustion will dominate for the rest of this century. At current rates of development, combustion and precombustion technologies will not impact the major coal demand market—by that I mean the power industry—for some 15 to 20 years, making postcombustion technology the mainstay for the rest of the century. The chief reasons are uncertainty over whether these technologies will comply with current and future standards, the need for major modifications to utility furnaces, and traditional ways of preparing coals, and confusion over whether we are heading toward a coal-based economy or not.

I believe our industry is too small, too weak financially, too fragmented, and too dependent on Federal actions to cope with these questions independent of Federal participation. Under these circumstances, Federal involvement in R. & D. must continue, but I suggest taking the following additional steps to improve management of the program.

I suggest the EPA be free to work on new threats in coal combustion, fine particulates, heavy metals, organics, and allow DOE to develop the component and systems technologies. I also suggest that DOE be reorganized such that there is one person in charge of postcombustion, combustion and precombustion technology developments at a much lower level than at the assistant secretary level. The objective would be to give DOE technical managers the authority to decide on tradeoffs among the three phases of combustion. Furthermore, retaining these decisions within one agency, DOE will improve the conduct of R. & D. immeasurably. Those are the extent of my comments and I await any further questions.

[The prepared statement of Mr. Anthony follows:]

STATEMENT OF

TOBIAS ANTHONY

DIRECTOR BUSINESS DEVELOPMENT AND

WASHINGTON AFFAIRS

RESEARCH-COTTRELL INC

Mr. Chairman, members of the committee. I welcome this opportunity to offer whatever assistance I can in helping you to determine the proper role of the federal government in the R&D that is needed to burn coal cleanly.

My name is Tobias Anthony. I am Director of Business Development and Washington Affairs for Research-Cottrell. With me is Alan B. Walker, Vice President for Planning for our environmental companies.

The history of the movement to burn coal cleanly is also the history of Research-Cottrell. More than seventy years ago, Dr. Frederick Gardener Cottrell invented the electrostatic precipitator To this day, this is the primary equipment used to eliminate fly ash, otherwise known as particulates, from coal fired power plants. Over those years, we have invested heavily in other developments, such as, the sulfur dioxide scrubber, spray dryers used for sulfur dioxide control, fabric filters used to trap particulates and chemical coal cleaning systems.

One cannot be in this business so long and be involved in long range R&D so deeply without developing a business philosophy as well as strategies which focus on how to burn coal cleanly and economically. My purpose today is not to critique specific government funded R&D programs, but rather lay out our thoughts which you may find useful in formulating a national strategy.

At the outset we need to discuss what motivated our industry in the past to invest in R&D and what motivates us today. In that way, one can arrive at a conclusion as to what should motivate the federal government. We need to understand the current climate for investment, and consequently, make some guesses as to what the fucure role of the private and government sectors will very likely be. Finally, within the government sector we have some thoughts as to what the proper role should be for DOE and EPA.

A GOVERNMENT DOMINATED MARKET

Let us emphasize at the outset that the air pollution control market is totally dominated by laws and regulations. Last year, the market reached 1.5 billion dollars, which on the face of it should be reason enough for the private sector to participate in it. However, this year the market is very likely to be half as large. Furthermore, this sort of undulation has occured each time the Clean Air Act has come under review, since the Clean Air Act not only specifies which pollutants shall be controlled, it also requires that standards (NSPS) be premulgated to specify the extent of control.

The last time the Clean Air Act was changed, it took two years to debate and pass the act and another two years to generate the new source performance standards. Our industry and the users of our equipment very nearly sat to await the outcome. On top of this period of uncertainty, remember the Clean Air Act calls for review of the new source performance standards every four years. So in effect, based on the experiences of the 1976-79 period, standards are in effect for one year before it becomes time to decide whether they should be changed.

PRIVATE SECTOR-LONG RANGE R&D

This is the essential reason the private sector no longer engages in long-term R&D in the air pollution control market. We learned there is no telling what the market will be when standards become a moving target. After all, investment in R&D requires the same calculations as the internal-rate-of-return and payback decision as any other form of investment. The one difference is that in deciding on R&D projects we realize it takes much longer for the payback period before the profit stream begins. It is common these days of high costs of capital to look at payback periods of ten to fifteen years, from laboratory to demonstration stages. That means standards that can change every four years could obsolete technologies long before the payback period is realized. Private sector firms therefore, opt for near term product improvement type R&D, with payback periods of three to four years, when they consider using internal funds.

This was not always the case. Typically, Reseach-Cottrell invested it's own money prior to the effects of the passage of the Clean Air Act of 1970. We invested at a rate of approximately 1½ to 2 percent of sales in long range R&D, a ratio that was in line with other capital goods industries. Today we spend much less of our own money and make up the difference with federal funds.

THE CLEAN AIR ACTS OF 1970 AND 1977

We felt the effects of the Clean Air Act of 1970 by 1974. It was then that we realized what it meant to be in a regulated market. Prior to that time, our marketplace responded to the traditional market forces. Customers believed emmission limits were modest, compliance was affordable and well within the technical state-of-the-art. Government goals were modest, so all governments with states leading the way sought to persuade pollution sources to clean up in order to improve ambient conditions. Consequently, the market was more or less predictable, which is a necessary precursor to planning long range R&D investments.

The public's impatience with the pace of achieving environmental quality lead Congress to pass the Clean Air Act of 1970. The Act called for two drastic changes. It called for sharper limits on particulate emission control from coal-fired boilers and, for the first time, it called for post-combustion clean-up of sulfur dioxide. A more subtle and fundamental change also occurred we were to find out. It took authorities away from the states and gave them to a new agency, the Environmental Protection Agency.

The EPA's mandate was to crack down on pollutant emissions. While technology existed to control particulates, no technology existed to control sulfur dioxide. This fact led to crash programs sponsored by EPA to develop flue-gas desulfurization systems and to push the state-of-the-art of electrostatic precipitators. Since the EPA's mandate required that demonstration technologies exist before the standards could be imposed, EPA funded a host of control technologies to optimize future standards. Many of these scrubber technologies did not work well, which aggravated the position already established by utilities that sulfur dioxide control was not needed in the first place.

The results would be obvious. The Clean Air Act would force technology on users and create huge markets. But huge markets for some, mean huge costs to others. The rebellion that took place among users of our equipment forced the end of a typical customer-supplier relationship. Although markets were huge, unpredictability on the part of customers made long range planning fruitless. The Clean Air Act of 1977 simply aggravated the problems even more, since it forced even tighter controls and limited options further.

Now, it is not only imprudent to engage in R&D, it is absolutely unrealistic to assume the private sector will.

THE STATE-OF-THE-ART OF CLEAN-UP TECHNOLOGY

Remember at this point we are talking about controlling only two pollutants from coal burning facilities: particulates and sulfur dioxide. At this point it is generally agreed, control technology works. It is also generally agreed there probably are more cost-effective ways of controlling these pollutants.

To understand the subject fully, let us separate the objective of burning coal cleanly into it's sectors:

(A) Pre-Combustion

(B) Combustion

(C) Post-Combustion

To this point we have been discussing post-combustion clean-up technology. It involves equipment installed between the furnace and the chimney. The available technologies are fully developed and commercial. They include electrostatic precipitators, baghouses, limestone scrubbers, and spray dryers in various configurations. There is only one technology that needs to be developed now and that is the one that will combine particulate, sulfur dioxide and nitrogen oxide control in one system. I believe it will lead to the most near term cost-effective system, but the private sector will not invest in this system until it knows what the future NO_x standard will be. The federal government will have to make the investment because the private sector is concentrating it's resources and energies on improving current technology to meet current standards.

What about Pre-Combustion? It makes alot of sense to remove pollutants from coal at the source. Current technology consists of time worn physical coal cleaning. Physical coal cleaning with the proper attention offers the prospect of eliminating maximum quantities of of residue while providing optimum amounts of Btu's. Furthermore, more work is needed in determining disposal of heavy metals and potentially carcinogenic organic hydrocarbons. The future of pre-combustion however, lies in a combination of physical and chemical coal cleaning. Chemical coal cleaning is at the test tube stage and requires major emphasis by the government if it is to replace post-combustion clean-up technology.

As for combustion clean-up systems, once more the federal government has led the private sector. Much progress resulted from DOE's fluidized bed program at Georgetown, but commercializing fluidized bed to achieve maximum use of coal requires redesigning utility furnaces and that would take much convincing before it becomes acceptable in the marketplace. A second technology which holds substantial promise is limestone injection, since modifications to the furnace box are less drastic.

It is clear we will have to depend upon post-combustion technologies for some time into the future. It is also clear, technologies with the potential to be most cost-effective lie toward the front-end of the system. My feeling is that the private sector will spend their own money on improving cost-effectiveness of existing technology in the post-combustion area (except for the combined program), but federal funds will be needed in the other two sectors.

IS COAL BURNING A NATIONAL GOAL ?

It is understandable that the federal government might sit back and say it will spend no money in this sector at all. If so, it will take decades for these technologies to become commercial. Is it our national policy to base our economy on coal, in as short a term as possible? And if we still expect to reduce or eliminate our dependency on imported oil in the next decade or so? And if it continues to be our policy to elminate pollutants whenever they are detected and wherever they occur? Then the federal government must engage in this R&D needed to satisfy national policy. That is to say, the federal government will have to cover the early risk period just prior to demonstration, before the private sector will assume responsibilities.

There is another approach to consider. Now that our post-combustion technology can reduce sulfur oxides and particulates by a range of 95-99%, freeze standards for ten years or more. There is sufficient money in the marketplace to induce inventors to develop the most reliable, the most cost-effective technologies in whatever phase of combustion makes the most sense. But if the Congress reserves a right to itself, that standards might change at any time because health and welfare would be better protected by tighter limits, then the private sector will be reluctant to take the initiative.

WHAT ABOUT NEW CRITERIA POLLUTANTS?

For good reason I limited the discussion to two pollutants. Potentially, there are others that are considered a threat, such as, heavy metals, fine particulates, and organic compounds, which are emitted during combustion. Obviously, new R&D programs will be needed to control or substitute for these hazards.

This brings up the point of which agencies should be involved in this sort of R&D. It seems to me quite clear the Environmental Protection Agency should be responsible for developing best available control technology for new threats, since they are responsible for setting standards based on available technology.

On the other hand, the DOE should be responsible for component and systems development needed to integrate this technology into a energy system.

Now I am talking about responsibility. Ultimately, it is the private sector who will provide the technology.

I thank you for this opportunity and I hope this testimony will be fruitful during your deliberations.

Mr. **Brown**. Thank you very much. I would like to go back to Dr. Mahoney and to welcome you here. You are speaking on a subject that is near and dear to my heart, so be my guest.

Dr. **Mahoney**. Thank you, and I do apologize for coming in the door after you called this panel to their seats. I want to start by thanking you for inviting me to present my analysis on research and development needs with a special focus on monitoring the measurement of air pollution.

My name is James R. Mahoney. I am senior vice president of Environmental Research and Technology, Inc., or ERT, and I am speaking from the perspective of approximately 16 years, experience in an academic and technical consulting practice in the environmental field with a special emphasis on air pollution control policy.

The theme of my remarks can be expressed as follows: In my view, available or even reasonably anticipated, source control technology is unlikely to fully resolve the Nation's most important remaining air quality issues—including acid rain, elevated ozone concentrations, and visibility impairment—during the decade of the 1980's. Therefore, well-conceived air pollution monitoring programs have an increasingly important role to play in defining and implementing the control strategies which will optimize the limited air quality improvements we may expect to experience during the next few years.

The development of air pollution source control technology, as fostered by the 1970 Clean Air Act and its 1977 amendments, has produced significant improvements in our Nation's air quality during the past decade. Among the principal improvements are the following:

One, reduction of sulfur dioxide (SO_2) emissions through increased use of low sulfur fuels, and the adoption of flue gas desulfurization (FGD) technology for major new combustion facilities.

Two, reduction of primary particulate emissions, through improved operation and maintenance practices at many industrial and commercial facilities, and the adoption of improved particulate collection and removal technology at both existing and new industrial facilities. However, I note, by exception, secondary particulate formation—that related to condensation of gaseous effluents in the atmosphere—has probably increased during the past decade.

Three, reduction in the emissions of volatile organic compounds, through process and materials changes, and the installation of vapor recovery systems at many facilities.

Four, major emissions reductions from the Nation's vehicle fleet.

These various emissions reductions have brought about a significant improvement in the profile of attainment of the health-related, primary national ambient air quality standards (NAAQS) (except for the ozone standard) for most of our population. The only important geographical exceptions to this trend are those found in several rapidly growing communities in the Sun Belt region, where, in fact, the growth of activity has overwhelmed the improvements achieved by controls.

The principal remaining national scope air quality issues share the common feature that they result, in large part, from long distant transport of pollutants. The long transport distances involved, and the large number of sources contributing to the regional pollutant loadings, pose a highly challenging dilemma in the search for effective control strategies.

On the one hand, additional emission controls implemented on individual facilities will normally have negligible effect on regional patterns of acid rain, ozone concentrations, and visibility impairment. On the other hand, requirements for additional controls at all major emitting facilities in a region could impose prohibitively large costs upon the regional or national economy. Cost-effective resolution of this dilemma, resulting in significant improvements in regional air quality problems, is the greatest challenge facing air pollution control during the 1980's.

In my following remarks which I will abbreviate, I want to briefly illustrate an idea of the role of improved monitoring in the development and implementation of effective controls for the principal regional scale air pollution problems.

I have attempted to do this by being so bold as to suggest an experiment to illustrate a point, but with real feeling about the validity of the methodology and experiment involved. I suggest in the area of acidic deposition or acid rain and its related phenomenon we consider the possibility of regional experiments with variable emission controls.

Increasing concern about acid rain and related phenomenon has been widely evidenced by both the scientific community and the general public during recent years. The need to understand the causes, effects, and possible controls for acid rain has intensified, especially in the Northeast, in view of the attempts to accelerate the conversion of large industrial and utility boilers to the use of domestic coal. In my view, it is unlikely that the occurrences of acid deposition will be significantly reduced during the next several years, for a number of reasons:

Uncertainties in the development of technology, and the long leadtime involved, mean that there will be a slowdown or impedance to implementation of permanent controls in many existing facilities.

Second, from the technical viewpoint, the limited records of long-term, self-consistent precipitation acidity observations which we do have available, do not particularly demonstrate changes in precipitation acidity, even when regional emission loadings are known to have changed significantly during the observation period.

And thus, it is the converse which troubles us. That is, if we now set out to positively impose changes in emissions, we would hope that the data would show us or at least suggest that we might find improvement, and I am concerned that we do not see that in the data at this time.

Third, we should remember that even if available sulfur dioxide control technology were installed on large boilers in affected regions, remaining nitrogen oxide emissions and emissions of SO_2 from other sources may still contribute to acid rain phenomenon which might occur in the same range we presently see.

Data available from recent field studies suggest that an experimental demonstration of time variable emission controls, applied on a regional basis, could yield substantial benefits during the next few years. This is my "chicken soup argument"; it can't hurt, and it probably can help, in an era when at least in the next few years we will have great difficulty in achieving any improvement in acid rain phenomena.

The phenomenon we see in available data which care of special note:

Elevated sulfate concentrations are related to specific regional scale meteorological conditions, and not simply to emission strength;

Incidents of maximum concentration tend to occur in episodes which typically persist for a few days, and,

Patterns of elevated concentrations tend to be regional, extending over several hundred miles at a time with only limited change.

These findings suggest a possibly important role for monitoring driven, time-variable emission controls applied at several major combustion facilities in the Northeast. An experimental program could be organized within 2 or 3 years—thus, well before permanent controls could be broadly implemented—incorporating the following features:

First, a need for a limited supply—that is, 30 days per annum—of low sulfur coal, stored for use in the facilities which can switch coal types readily.

Second, a regional monitoring network—many elements of which are already in place—adequate to assess changes in regional patterns of SO_2 and sulfate particulate concentrations, and in precipitation chemistry.

Third, a meteorological and operational forecasting protocol to be used to coordinate the use of low sulfur coal during designated periods. These periods would typically run a few days at that time, that is corresponding to expected episodic conditions.

The cost of such an experiment would be small compared to the permanent control costs for even a single major facility, and several benefits would result:

First, the experiment would demonstrate a useful long-term role for such monitoring driven, time-variable emission limits in reducing the occurrences of regional-scale acidic deposition.

Here the argument is that we simply don't have the luxury to spend the resources necessary to get regional controls on all of the necessary sources.

Second, substantial information on the cause-and-effect relationship between regional emission loadings and acidic deposition patterns would be developed.

The development and evaluation of well-founded regulatory strategy options would be enhanced.

I recognize that the type of demonstration experiment I am suggesting could only be implemented with the affirmative cooperation of several public and private-sector organizations. However, the alternative approach of permanent retrofit controls on all major combustion facilities would be extremely costly for the Nation, would require many years to implement, and might itself not adequately resolve the issue of acidic deposition.

Thus, I recommend that the committee give considerable weight to its consideration of the role of monitoring and field measurement programs in the development, and possibly in the implementation, of control strategies which will allow increased domestic coal use consistent with adequate control of acidic deposition in the Northeast and elsewhere as needed within the Nation.

Mr. Chairman, I have commented briefly in my prepared material also about major continuing questions and problems related to the observations of elevated ozone levels in much of the country and related to the great state of uncertainty in our scientific knowledge about visibility impairment and its causes. And I here simply suggest for the record that these issues, as well, need continued full address at the research level.

In an ideal world, the research it would come before the point of control. In the practical world, I have to urge at least that we continue adequate research programs while we implement the beginnings of various control programs.

Thank you very much.

[The prepared statement of Dr. Mahoney follows:]

STATEMENT OF JAMES R. MAHONEY
SENIOR VICE PRESIDENT
ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.

Mr. Chairman:

Thank you for inviting me to present my analysis of research and development needs in the areas of air pollutant control, monitoring and measuring, and pre-construction control.

I am James R. Mahoney, Senior Vice President of Environmental Research & Technology, Inc. I am speaking from the perspective of sixteen years experience in an academic and technical consulting practice in the environmental field, with a special emphasis on air pollution control policy and planning.

The theme for my remarks can be expressed as follows: In my view, available, or reasonably anticipated, source control technology is unlikely to fully resolve the nation's most important remaining air quality issues (including acid rain, elevated ozone concentrations and visibility impairment) during the decade of the 1980's. Therefore, well conceived air pollution monitoring programs have an increasingly important role to play in defining and implementing the control strategies which will optimize the limited air quality improvements we may expect to experience during the next few years.

The development of air pollution source control technology, as fostered by the 1970 Clean Air Act and its 1977 Amendments, has produced significant improvements in our nation's air quality during the past decade. Among the principal improvements are the following:

1. Reduction of sulfur dioxide (SO_2) emissions through increased use of low sulfur fuels, and the adoption of flue gas desulfurization (FGD) technology for major new combustion facilities.

2. Reduction of primary particulate emissions, through improved operation and maintenance practices at many industrial and commercial facilities, and the adoption of improved particulate collection and removal technology at both existing and new industrial facilities. (However, secondary particulate formation, by condensation of gaseous effluents in the atmosphere, has probably increased during the past decade.)

3. Reduction in the emissions of volatile organic compounds, through process and materials changes, and the installation of vapor recovery systems, at many facilities.

4. Major emissions reductions from the nation's vehicle fleet.

These various emissions reductions have brought about a significant improvement in the profile of attainment of the health-related, primary National Ambient Air Quality Standards (NAAQS) (except for the ozone standard) for most of our population. The only important geographical exceptions to this trend are found in several rapidly growing communities in the Sunbelt region.

The principal remaining national-scope air quality issues share the common feature that they result, in large part, from long distance transport of pollutants. The long transport distances involved, and the large number of sources contributing to the regional pollutant loadings, pose a highly challenging dilemma in the search for effective control strategies. On the one hand, additional emission controls implemented on individual facilities will normally have negligible effect on regional patterns of acid rain, elevated ozone levels and visibility impairment. On the other hand, requirements for additional controls at all major emitting facilities in a region could impose prohibitively large costs upon the regional or national economy. Cost effective resolution of this dilemma, resulting in significant improvements in regional air quality problems, is the greatest challenge facing the air pollution control field during the 1980's.

The following remarks briefly illustrate the important role of improved monitoring in the development and implementation of effective controls for the principal regional-scale air pollution problems.

ACIDIC DEPOSITION -- A SUGGESTION FOR REGIONAL EXPERIMENTS WITH VARIABLE EMISSION CONTROLS

Increasing concern about acid rain and related phenomena has been widely voiced by both the scientific community and the general public during recent years. The need to understand the causes, effects and possible controls for acid rain has intensified, especially in the Northeast, in view of the attempts to accelerate the conversion of large industrial and utility boilers to the use of domestic coal. It is unlikely that the occurrences of acidic deposition will be significantly reduced during the next several years, for a number of reasons:

1. Uncertainties in defining effective and efficient regulatory strategies, combined with the high cost and long lead times required to install retrofit controls on major existing facilities, will necessarily impede the implementation of permanent controls in many cases.

2. The limited records of long term, self-consistent precipitation pH observations (especially the New York State data collected from 1964 to 1972) do not demonstrate changes in precipitation acidity, even when regional emission loadings are known to have changed significantly during the observation period.

3. Even if available SO_2 control technology were installed on all major boilers in the Northeast (at a very high cost), the remaining NO_x emissions from these sources, perhaps combined with SO_2 emissions from smaller sources, may still be adequate to cause significant acid deposition.

Data available from recent field studies suggest that an experimental demonstration of time variable emission controls, applied on a regional basis, could yield substantial benefits during the next few years. For example, extensive observations obtained during conduct of the Sulfate Regional Experiment have demonstrated that:

- elevated sulfate concentrations are related to specific regional scale meteorological conditions, and not simply to emission strength;
- incidents of maximum concentration tend to occur in episodes which typically persist for a few days, and,
- patterns of elevated concentrations tend to be regional, extending over several hundred miles at a time.

These findings suggest a possibly important role for monitoring driven, time-variable emission controls applied at several major combustion facilities in the Northeast. An experimental program could be organized within two or three years (i.e., well before permanent controls could be broadly implemented), incorporating the following features:

- A limited supply (e.g., 30 days per annum) of low sulfur coal, stored for use in the facilities which can switch coal types readily.
- A regional monitoring network (many elements of which are already in place) adequate to assess changes in regional patterns of SO_2 and sulfate particulate concentrations, and in precipitation chemistry.
- A meteorological and operational forecasting protocol to be used to coordinate the use of low sulfur coal during designated periods.

Because of the regional, episodic nature of the observed sulfate distributions, the protocol for the experiment might include periods of low sulfur coal use typically extending from three to five days continuously, to be repeated several times each year, corresponding to the occasions when maximum sulfate concentrations are expected.

The cost of such an experiment could be small compared to the permanent control costs for even a single major facility, and several benefits could result:

- The experiment could demonstrate a useful long term role for monitoring driven, time-variable emission limits in reducing the occurrences of regional-scale acidic deposition.
- Substantial information on the cause and effect relationship between regional emission loadings and acidic deposition patterns could be developed.
- The development and evaluation of well-founded regulatory strategy options would be enhanced.

I recognize that the type of demonstration experiment I am suggesting could only be implemented with the affirmative cooperation of several public and private sector organizations. However, the alternative approach of permanent retrofit controls on all major combustion facilities would be extremely costly for the nation, would require many years to implement, and might itself not adequately resolve the issue of acidic deposition. Thus, I recommend that the

Committee give considerable weight to its consideration of the role of monitoring and field measurement programs in the development, and possibly in the implementation, of control strategies which will allow increased domestic coal use consistent with adequate control of acidic deposition in the Northeast and elsewhere as needed within the nation.

OTHER REGIONAL ISSUES -- ELEVATED OZONE LEVELS AND VISIBILITY IMPAIRMENT

I am not suggesting time variable emission controls as an aid in the management of elevated ozone levels. However, I believe that there is a compelling need for continuted support of programs of field measurement and research aimed at defining the causes of, and possible controls for, the broad regional patterns of elevated ozone levels which are observed in many parts of the nation, particularly during summer months. Questions to be resolved include the following:

1. What are the causes of the broad, nearly uniform, patterns of high ozone concentration which extend over many hundreds of miles in the eastern half of the nation?

2. Will further reductions in hydrocarbon emissions, concentrated in the larger population centers, have any beneficial effect on the nearly uniform regional patterns of elevated concentrations?

3. What are the relative contributions of anthropogenic and natural sources of ozone, especially for locations distant from population centers?

Similarly challenging questions concerning the interpretation of field data on visibility impairment can be cited. Among the major unresolved issues are the following:

1. The effects and relative importance of different atmospheric pollutants on visibility. While studies suggest that sulfates may be largely responsible for reduced visibility in the Eastern United States, organic aerosols may be of comparable significance in the Southwest. Thus, there is a need to analyze the effects of carbonaceous aerosols, wind-blown dust, soot, fly ash and secondary nitrate aersols, as well as sulfates.

2. The relationship between meteorological conditions and atmospheric pollutants in reduced visibility.

3. The development of workable, validated models for visibility impairment.

Until these and related questions are adequately resolved, it will be impossible to develop an efficient and effective control program to mitigate visibility impairment in many regions of the nation. I hope that my remarks have been adequate to demonstrate that a significant need exists for pollutant monitoring and research, to guide the development of the control technology needed to resolve the regional air quality issues which have assumed increasing importance in recent years.

Thank you again for yourinvitation to present my views to the Committee.

Mr. OREM. We would like to comment on R. & D. activities in air pollution control technologies specifically dealing with the major pollutants SO_2, NO_x and particulates. A general discussion on the Federal role, the private sector's role, and the areas where future development will likely require Government assistance.

In SO_2 control technology we like to think that this technology has achieved a dramatic maturity. Less than 10 years ago, plant operators were skeptical of new FGD technology and associated costs, and were reluctant to commit the required large capital equipment purchase.

Plant owners challenged the regulatory requirements and usually insisted upon field demonstrations. Numerous pilot plant projects were undertaken by the Federal EPA, the equipment suppliers, and various user industries. Specifically, these demonstrations were to show that the FGD systems could be made to operate efficiently, reliably and within reasonable cost parameters. In general, these objectives were satisfied.

These early successes provided the EPA with a framework of support for its regulatory program. As plant operators became more comfortable with the chemical processes technology, the R. & D. effort shifted toward system simplification and improvement. The competitive pressures of the marketplace provided a strong stimulus for component and materials research to reduce system cost for process optimization, allowing improved system guarantees.

All major FGD system suppliers will continue to fund these product development programs to insure a future competitive position in the marketplace.

Since we accept this technology as matured, the future R. & D. needs will be predominantly applied research for product improvement. We do feel the EPA should stand ready to offer support for any new methodology which may be seen as true innovation.

The statistics supporting the success of FGD technology are indeed impressive. A total of 118 systems (46,000 megawatts of capacity) are currently operational or under construction. Twenty-one companies have supplied 84 FGD systems for the electric utility market, representing 31,000 megawatts of installed operating capacity. Operating experience has been attained on old and new coal-fired boilers, on a wide range of coal sulfur levels. Roughly a third of the operating units are treating combustion gases from units firing coal with sulfur levels in excess of 3 percent.

The majority of the operating systems are achieving high reliability at or above guaranteed performance levels, a majority in excess of 90 percent, and many systems consistently achieve over 95-percent reliability.

Approximately 94 percent of the total currently operating utilizes lime, limestone or sodium-based systems which all generate a waste material which is discarded. Most of this waste is treated prior to disposal to minimize environmental degradation. The resulting leachates meet all standards.

Acid rain, its causes and consequences, is an area where studies should be accelerated so Congress will have adequate information at the earliest date. If acid rain is judged a problem requiring urgent action, technology is available to reduce that danger.

A few comments on the hardware. Since the introduction in the utility industry in the 1920's, electrostatic precipitators have become the most widely used means of controlling fly ash emissions from coal-fired boilers. This technology has progressed via applied product improvement research as a result of natural competitive pressures. However, with more strict regulation on particulate emissions and stack opacity, ESP systems have grown larger and more costly.

Applied R. & D. is aimed at improved forms of electrical energization, new rectifier and rapping controls and gas velocity distribution. Fabric filtration has been demonstrated and accepted as a competing technology for particulate control on coal-fire boilers. As with FGD, this application has opened and gone through pilot plants and demonstration, all within the last 10 years.

A considerable number of industrial and utility particulate fabric filters have been committed and many are in operation.

Product development is now aimed at reducing pressure drop, hence operating cost, via improved fabrics, improved maintainability, improved bag cleaning schemes and electrostatic enhancement. Here again EPA should stand ready to offer support for any new methodology which might be seen as true innovation.

A particulate control technology assist is through gas conditioning where chemical additives are injected into the flue gas stream to improve particle behavior and capture electrostatic precipitators. This is now used primarily on existing equipment, but it can improve the efficiency of new precipitators in many cases. The successful track record of this technology during the past 5 years indicates no additional EPA research funds are needed.

Post-combustion NO_x control technology in the United States is for the most part developmental. Some systems employing catalysts, initially developed in the United States, are beyond the development stage and operating successfully in Japan where NO_x limits are more strict. The basic technology is known and ready to be applied here but has not since the June 1979 NSPS requirements were set at the best limits attainable via combustion modification.

Federal Government research dollars have been concentrated on limiting NO_x emissions by the combustion modification method. EPA might support the further development and demonstration of this technology in two ways.

First, it might clarify its position on NO_x control via new source of performance standards, in numerical terms, issued for a fixed time frame during which newly permitted sources would be shielded from additional requirements. This would insure a greater period of certainty to the advantage of the users in planning new facilities and obtaining a reasonably useful life from pollution control installations.

Second, the Federal Government could increase research funds for postcombustion NO_x control demonstration projects. These dollars would provide the impetus to move NO_x control technology from the developmental stage to an operational status.

R. & D. in the private sector is fundamental to the stability and growth of the technical base of a company. Often, significant contributions to sales and profits are generated by products not even marketed 5 or 10 years ago. However, companies must evaluate R. & D. projects on the basis of their ability to provide an adequate return on the projected capital investment and in light of the degree of technical or commercial risk involved.

The air pollution control market has attracted scores of companies during the last decade on what seemed to be tremendous growth and profit potential. Optimistic judgments and postcontract expenses have caused a number of newcomers and a few oldtimers to disappear.

The Federal Government, by providing partial funding of demonstration projects, has helped achieve dramatic results in air pollution control technologies. With continued support we will continue to move forward toward our goal of cleaner air.

[The prepared statement of Mr. Orem follows:]

Statement Of
INDUSTRIAL GAS CLEANING INSTITUTE
and
ENVIRONMENTAL INDUSTRY COUNCIL

presented by

SIDNEY R. OREM

The Environmental Industry Council and the Industrial Gas Cleaning Institute are national associations representing the pollution control equipment industry.

This statement deals with research and development activities on air pollution control technology; specifically those major pollutants SO_2, NO_x and particulates. Included is a general discussion on the federal government role in funding these expenditures, how the private sector currently views air pollution control research and development project costs, and the areas of future development which will likely require government assistance.

SO_2 Control Technology

SO_2 control technology has achieved dramatic maturity. Less than a decade ago, plant operators were skeptical of new FGD technology and associated costs, and were reluctant to commit the required large capital equipment purchases. Plant owners challenged various regulatory requirements and usually insisted on a demonstration of technology. Numerous pilot plant projects were undertaken by the federal EPA and by many air pollution control equipment suppliers and various user industries. The primary objective of these early development programs was to demonstrate the viability of the basic chemical processes involved. Specifically, to show that the FGD systems could be made to operate efficiently, reliably and within reasonable cost parameters. In general, these objectives were all satisfied. These early successes provided the EPA with a framework of support for its regulatory program.

As plant operators became more comfortable and experienced with the chemical process technology, the research and development efforts shifted towards system simplification and improvement. The competitive pressures of the marketplace provided a strong stimulus for component and materials research to reduce systems cost and for process optimization, allowing improved system guarantees. All major FGD system suppliers will continue to fund these development programs to insure the future competitive status.

Since FGD is essentially a matured technology the future R&D needs will be predominately applied research for product improvement. However, the EPA should stand ready to offer support for any new methodology which would be seen as a radical innovation.

The statistics supporting the success of FGD technology are impressive.

- A total of 118 systems (46,000 MW of installed capacity) are currently operational or under construction.
- 21 companies have supplied 84 FGD systems for the electric utility market, representing 31,000 MW of installed operating capacity.
- Operating experience has been attained on old and new coal-fired power boilers and on a wide range of coal sulfur levels. Roughly a third of all operating units are treating combustion gases from units firing coal with sulfur levels in excess of 3%.
- The majority of the operating systems are achieving high availability at or above guaranteed performance levels -- a majority in excess of 90% and many systems consistently achieving over 95% reliability.
- Approximately 94% of the total current operating capacity utilizes lime, limestone, or sodium based systems which all generate a waste material which is discarded. Most of this waste is treated prior to disposal to minimize environmental degradation. The resulting leachates meet all RCRA standards.

Particulate Control Technology

Since their introduction to the utility industry in the 1920's, electrostatic precipitators have become the most widely used means of controlling flyash emissions from coal-fired boilers. Plant designers and operators are very familiar and experienced with this technology, having purchased and operated thousands of ESP systems. This technology has progressed via applied product improvement research as a result of the natural competitive pressures of the marketplace. However, with more strict regulations on particulate emissions and stack opacity, ESP systems have grown larger and more costly. Applied R&D or product development is presently aimed at improved ESP performance via new forms of electrical energization, new rectifier and rapping controls and improved gas velocity distribution.

Fabric filtration has been demonstrated and accepted as a competing technology for particulate control on coal-fired boilers. As with FGD, this application has opened and gone through pilot plant and demonstration stages within the last ten years. A considerable number of industrial and utility particulate fabric filters have been committed and many are in operation. Fabric filters have been used for many years in other industries and offer very high efficiencies, even on extremely fine particles. Product development is now aimed at reducing pressure drop (hence operating cost) via improved fabrics, improved bag cleaning schemes and electrostatic enhancement. EPA should stand ready to offer support for any new methodology which might be seen as radical innovation.

Another particulate control technology area is flue gas conditioning where chemical additives are injected into the flue gas stream to improve particle behavior and capture an electrostatic precipitator. The process is now used primarily on existing equipment, but can improve the efficiency of new precipitators in many cases. The successful track record of this technology during the past five years indicates no additional EPA research support funds are needed.

NO_x Control Technology

Post-combustion NO_x control technology in the United States today is, for the most part, developmental. Some systems employing catalysts initially developed in the U.S. are beyond the development stage and operating successfully in Japan where NO_x emission limits are more strict. The basic technology is known and ready to be applied here, but has not since the June 1979 NSPS requirements were set at the best limits attainable via combustion modification. Federal government research collars have been concentrated on limiting NO_x emissions by the combustion modification method.

The EPA can support the further development and demonstration of this technology in two ways. First, it can clarify its position relative to NO_x control. New source performance standards in numerical terms should be issued for a fixed time frame during which newly permitted sources would be shielded from additional requirements. This would ensure a greater period of certainty to the advantage of users in planning new facilities and obtaining a reasonable useful life from pollution control equipment. Secondly, the federal government should increase research funds for post-combustion NO_x control demonstration projects. These dollars for applied research would provide the impetus to move NO_x control technology from the developmental state to an operational status.

Private Sector Research and Development

Research and development is fundamental to the stability and growth of the technical base of a company. Often, significant contributions to sales and profits are generated by products which were not marketed ten or even five years ago. However, companies must evaluate R&D projects on the basis of their ability to provide an adequate return on the projected capital investment and the degree of technical and commercial risk involved. The air pollution control market has attracted scores of companies during the last decade with what seemed to be tremendous growth and profit potential. Optimistic judgments and post-contract expense have caused a number of newcomers and a few "old-timers" to disappear.

The federal government, by providing partial funding of demonstration projects, has helped achieve dramatic results in air pollution control technologies. With continued support, industry and government will achieve even greater results in clean air.

Mr. BROWN. Thank you. That seems to be a rather optimistic statement. Mr. Anthony, you were a little pessimistic about the reasonableness of R. & D. by private industry in view of the chaotic regulatory environment. Is there anything in Mr. Orem's statement that you have a problem with or is he overly optimistic about this?

Mr. ANTHONY. I was emphasizing long-range R. & D., and I think most of the companies in our industry, including our own, spend quite a bit of money on near-term R. & D.

To go back to that example of some 10 to 12 years required to go from test tube to the first sale, our tendency is to look for support from the outside for those early years, in order to shorten up the cycle, the cost of capital being what it is.

To give you an example of the regulatory change, in 1977 we had an act which called for sharp reduction of sulfur dioxide. In 1979 we had a standard that defined the extent of that reduction. Here it is 1981 and now that standard could possibly change again. There isn't enough time in that frame to put a heavy commitment into a particular long range sulfur dioxide technology, so the tendency has been to buy foreign technologies that exist and use them.

Mr. BROWN. There are available foreign technologies that do the job available to the domestic market here in the United States?

Mr. ANTHONY. We have domestic and foreign. As far as sulfur dioxide is concerned, in particular, I think that we have got the technologies right now that we will probably have for the next 10 years.

Mr. BROWN. Well, I can sympathize with the situation of the control technology industry in what seems to be a fluid regulatory environment. But let me ask this question: Does private industry have the ability to overcome this regulatory uncertainty in the environmental field on the basis of projections of what is likely to happen in the next decade or two?

In other words, is there any incentive for private industry to develop its own expertise and leadership in this area, based upon its historical market relationship with the energy industries, and discount the fluctuations which are inevitable within governmental regulatory structures? Is this a reasonable posture?

Mr. ANTHONY. I don't think so. Particularly not for a new criterion pollutant. If our next group of pollutants becomes heavy metals or fine particulates, I don't think you will see private industry stepping forward very rapidly until it gets a determination of what the level of control is going to be, and how long will that control last?

Mr. BROWN. I recognize the weakness in the Government role and the Government's reaction to these problems. I have seen it fluctuate in this and other fields over a period of years. Yet, it seems to me that the answer is some improvement in the leadership in the private industry sector. You have to assume that there will be particular concerns for certain basics, public health, for example. I don't think the energy industry wants to be caught in the position of being accused of contributing to the destruction of public health.

Yet, I know that the utility industry historically has not committed a great deal of resources to long-range research. Because it was a regulated industry, it didn't see the motivation for doing that. Yet, I have sensed the change in this attitude in recent years.

The recognition that under rapidly changing situation, the industry must exercise more leadership rather than expecting the Government to exercise it. I am wondering if we can't encourage this? Possibly it is too much to expect but we may have to.

Let me explore another question with Dr. Mahoney. You have suggested some games that we might experiment with in terms of controlling pollution, basically from powerplants through a more careful monitoring, the replacement of high sulfur coal with low sulfur coal and so on. Do we have the technical capabilities that would include the kind of monitoring required to accomplish that kind of experiment?

Mr. Mahoney. Mr. Chairman, I think we do, because the time scale which I believe is appropriate for that kind of activity is a few days at length. That is, what I am suggesting is not some of the old supplementary control system approaches which concerned the ability to forecast compliance with a 3-hour SO_2 standard and move the powerplants around quickly, shifting fuels in order to bring about such changes.

When we look over time frames of, say, 3 to 5 days, the basic monitoring data which we need is that available from gaseous SO_2 monitors of which many operate—including many operating on a real-time basis, currently—and sulfate monitors which can be brought up to near real-time monitoring during the conditions which would be suitable for such shifts in any case.

I have tried to call this experimental because I think it would be foolhardy to say we are at a point where we could go out and effectively achieve major control this way. But I think the available instrumentation—I should say I think the instrumentation is available and that the constraints would be more the willingness of several diverse institutions to join together to make such a project run rather than the technological constraint of the instrumentation itself.

Mr. Brown. Is your company doing any experimenting with the use of satellites for monitoring environmental conditions such as on sulfates, ozone or some of these things?

Dr. Mahoney. We are not doing any, to the best of my knowledge, right now. We do do some resource mapping from several of the satellites, including, for example, snowpack mapping, water resource mapping, and so forth. But on the pollutant monitoring issue, the great difficulty is generally that the Nation does not spend the kind of development money for what I would call this fancy technology compared to the expenditure that are made in certain other areas which tend to have higher priority for rigid technology development.

Further, as a practitioner in the field, I am not convinced today that we need or that we would get ample return from such long distance monitoring. Clearly there is an important mapping function that would be provided if we could monitor well. The basic technological problem is that when we attempt to conduct passive monitoring, say, from a satellite platform or even from aircraft—although it would be more efficient by satellite—we are looking for a signal down in the clutter of all of the normal emissions from the ground and it requires a good deal of noise suppression, and therefore a highly expensive and precise technology.

I personally am not optimistic that we will see that much in the next few years, but I tend to also think that it is always unwise in one sense to say we can't do that, because we may be proved wrong tomorrow.

Mr. **Scheuer**. Regrettably, I have to leave for New York now. I want to thank the witnesses for their very interesting testimony. May I ask unanimous consent we be permitted to submit questions?

Mr. **Brown**. Yes.

Mr. Dunn?

Mr. **Dunn**. Dr. Mahoney, I am a little confused here. Dr. Anthony testified about the trends in the past that we have concentrated on postcombustion and perhaps in the future we ought to be concentrating on precombustion or the actual combustion itself. That happens to be a philosophy I agree with.

You state that, "In my view available, reasonably anticipated source control of technology is unlikely to fully resolve the nation's most important remaining air quality standards." I think in listening to the witnesses in the past, including yesterday and today, you are probably in the minority in that opinion.

No. 2, you conclude that the way to solve these problems is through better monitoring. Yet, the conclusion most of the other witnesses came to was that one of the big problems we have is in monitoring equipment. I think you made that point when you referred to one particular case where the acid rain count should have gone down and it didn't.

So if you are having a problem with the existing equipment, how do you make the case that providing more of that equipment will solve the problem? You sort of lose me in drawing that conclusion.

Dr. **Mahoney**. I appreciate the opportunity, Mr. Dunn, to try to clarify my statements in that area.

First I mean to draw my pessimistic comments rather narrowly about the pollutant problems that remain. Note that I am focusing on the long-distance transport problems, acid rain, sulfates, regional ozone patterns, regional visibility impairment problems. I tried to draw the distinction myself in the paper, too, that I believe we have made very significant improvement in near field impact controls, the controls which have brought about compliance with the ambient standards in many cases.

I recognize I may be in a minority in my pessimism; I thought carefully about it. Relative to those long distance transport issues, I retain that pessimism for the moment, anyway, and I do in particular because of my sense that providing adequate controls on all major combustion facilities, including all of the existing major powerplants and other industrial boilers, let's say, would be so prohibitively costly that we are not likely to see such control completely implemented over the next several years.

I believe that were we—if we had such controls, we would probably see significant progress. I would still be concerned about nitrogen oxide controls because I don't see that coming quickly on the horizon.

On the issue of monitoring, I would like to clarify an important point. What I am suggesting here really represents some interim, possibly helpful, steps using monitoring and exploring of possible roles of more aggressive use of monitoring data on the long term to set the level of control we need to impose.

Mr. **Dunn**. If it was an interim step, I would agree with you. But you made the point that the equipment doesn't exist today. So in terms of an austere budget, should we as Congress say let's spend money to continue to monitor the problem or should we address some of the things that Mr. Anthony was talking about and remove some of the obstacles which are the source of the problem? That seems to me a better use of dollars.

Let's not continue monitoring. Let's go to the source and get rid of it. We agree if we eliminate the source we don't need to monitor it?

Dr. **Mahoney**. I agree that we would only need trend monitoring or intermittent monitoring to keep track of the problems. I strongly support the concept that we should continue the enhancement and encouragement of control technology. That is where the action is and I want to make that clear.

I am certainly not trying to advocate monitoring in place of that. I am saying instead that the issues of control, in my view, the issues of control strategy adequate to remove the problems we see today are so demanding and potentially so costly, if we try to implement them broadly in the Nation we will have to make some choices about the level of control we can buy.

In that area I believe we continue to need some aggresssive monitoring and analysis of the actual circumstance we are dealing with.

Mr. **Dunn**. But is it going to take a lot of money to develop that equipment, or does it exist today? I seem to be getting two stories? Does it exist today?

Dr. **Mahoney**. I believe the monitoring equipment necessary exists right now. I don't believe there are any major new technological developments needed in monitoring for that purpose. I was commenting that I don't see any satellite monitoring coming to bear in the short term. But as to the rest of it, what I call conventional monitoring, I think we have all we need and all we need normally is the organization of such monitoring into workable programs.

Mr. **Dunn**. Would you agree with that opinion, Mr. Anthony?

Mr. **Anthony**. I couldn't comment on that.

Mr. **Orem**. I don't think that I'm adequately qualified to comment on that, either.

Mr. **Dunn**. Thank you.

Mr. **Brown**. Mr. Mahoney, I have casually followed the development of monitoring equipment over the last decade, and it seems to me that there has been really quite substantial improvement. Now, I would like to have you commment, if you would, on whether there are any substantial gaps, or whether we can expect to see continued improvements in the quality capability of monitoring equipment for the reasonably controllable air pollutants. Maybe, if you're qualified to comment as well, on this situation as it involves water pollution?

Dr. **Mahoney**. First, I would draw the line there and say I have nothing which I could be helpful about in the water area, so I will stick on the air side.

Mr. **Brown**. All right.

Dr. **Mahoney**. I generally agree that we have seen a significant improvement in monitoring technology in the last 5 or 6 years, I think, I would guess, in particular, much of it related to reliability, and the ability to run instruments on a long-term basis in the field and get usable data. My own firm has now had substantial experience for 10 years or more in running major monitoring programs. To give an idea, we are running probably 2,000 instruments in the field right now, for a whole range of industrial clients who have responsibility to report such data. Nearly all of these instruments are operating on a real-time continuous basis. When we started that activity in the early 1970's, with a rush of enthusiasm, many of the early programs started very well and we found in a few months that we had a very severe problem, because we could not keep the equipment running within specification, that is to calibration and so forth. So there was a great deal of useless data generated. I find much less of that problem in recent times. So I think the reliability and the routine operation of the equipment has increased really dramatically.

In a sense I think the market has forced this. There have been enough competitors, vendors of specific commercial instruments in the marketplace, so that the good equipment has survived and that which has had reliability problems, those have quickly been recognized and the vendors of such equipment have either changed or left that line of business.

On specific pollutants, there do remain gaps in my view. I think it is really unfortunate that more than 10 years after the major emphasis on air pollution control in the United States, we still largely rely on total suspended particulate measurments as the base measurement of particulate air quality in the United States. I believe we need further encouragement of particle size fractionating monitoring, because again we know that the small size particles are related to health effects.

There have been substantial developments in this area, in my view, in the last 3 or 4 years. But there has been relatively slow action by EPA or in the form of recognition by the Congress, I would say, where appropriate, in moving toward the fine particulate standard which may come now before long.

I would hope that we would see a much more rapid deployment of such instruments in the field because the greatest use of such monitoring data in most cases is simply the analysis of long-term trends. The real question that you want to have answered out of a monitoring network is if I take this year and next year, on the average is it 5 percent worse or 5 percent better and so forth; and where is it going over 3, 4, or 5 years?

The more rapidly we deploy such equipment, the better. I think all of the fine particulating equipment has a shakedown phase to go through in the field, when it goes out for such complete deployment, as we should have in every major urban area. I think we will have similar problems relative to the heavy metals. But what we call the standard U.S. pollutants, I believe there is a plateau of technology which has been reached. It would be very nice to see the costs drop. I don't know—I wouldn't be particularly optimistic about that, though.

Mr. Brown. Let me just ask one final question to the other two gentlemen. It has been the trend over several previous witnesses who discussed the question of EPA's research funding, that under the current conditions of fiscal austerity, that probably the work of the EPA on control technology should have the lowest priority. The reason, I presume, is that this is something that the private sector would be most likely to take an interest in.

I am rather inclined to feel that some sort of adjustment based on legislative conditions is going to be required, and I would like to know if you concur in the general observation that the EPA, through whatever system that it finds most effecive, should focus more on the longer-term and basic research, and leave the shorter-term or control technology, applied research, to the private sector. Would you generally concur with that analysis?

Mr. Anthony. I would like to commment on that, Mr. Chairman. I think when it comes to the relationship between DOE and EPA, that the management of component system technology would be better handled in DOE. My personal opinion is that the postcombustion technology is just about established to insure that we will get 90 percent reduction of sulfur dioxide, high sulfur coal 70 percent, low sulfur coal and particulates around 90 percent. There is more work to be done in the NO_X area. I think the private sector will develop that technology. There is enough incentive and enough near-term benefit.

But if we take a look at the precombustion area, physical coal cleaning and chemical coal cleaning, one who is a marketeer cannot say, I am going to rush over to that precombustion area and now spend my money there. The reason is that we wouldn't see a benefit from that investment for many years in the future.

I think the Federal Government should, and is bound to make, those initial investments. We need to have chemical coal cleaning systems. I don't know what they will be, but we need to have chemical coal cleaning systems to remove organic sulfur and reduce the residue.

There is evidence that we can float out quite a bit of heavy metals in the physical chemical coal cleaning system and hopefully, do it in the most cost-effective way, because I think inherently it will be more cost-effective.

In the combustion area, I think there is more work that has to be done in the combustion area as well. Those are the two.

I would like to make an additional comment. One good thing about being on a panel, you have time to think about the answers. You had mentioned before about utilities becoming more interested in funding R. & D. I think if we take a look at history, one realizes that from the 1970 to 1977 period, utilities were most adamantly against investing in SO_2 control because they didn't believe it was required.

As we went through the 1976, 1977, 1978, and 1979 debates, it became crystal clear that utilities were going to have to meet some new standard, it was going to be a very stringent standard, and that it was going to be very costly on a kilowatt basis. The utilities decided that they better do some of their own research to develop the most cost-effective equipment.

We have seen most of the good work coming out of EPA during that time frame. We in the air pollution control sector also feel that this type of EPRI institution would be a benefit, not for the postcombustion, but for the precombustion and the new criteria pollutants.

Mr. Allan Walker, vice president for Enviromental Cos., came up with this concept of a shared-funded program between our industry contributions and the Federal Government's.

I think it would benefit the marketplace to have more control over the tradeoffs from postcombustion down to precombustion, and to have control over those tradeoffs and not let people run off in directions as they see fit.

Mr. **Brown**. I appreciate that comment. I have been very pleased personally with the development of a mechanism like EPRI to handle the research needs of the industry. It is conceivable that we could probably could do more at the Federal level to remove obstacles to that type of development than we have in the past. There have been antitrust efforts, indicating that that sort of thing would be frowned upon, and I consider that an obstacle that we ought to take the responsibility to remove at the Federal level. Mr. Orem?

Mr. **Orem**. I would share most of what Mr. Anthony has said. I agree with him.

Mr. **Brown**. I have no additional questions, gentlemen. If you are willing to accommodate us if we think of anything vitally important that we need, we will submit it to you in writing. We would appreciate your help in completing the record in that way. I want to thank you for some very useful and interesting testimony.

Thank you very much. The subcommittee will be adjourned.

[Whereupon, at 4:15 p.m., the hearing was adjourned.]

CLEAN AIR ACT

THURSDAY, MAY 28, 1981

House of Representatives, Committee on Science and Technology, Subcommittee on Energy Development and Applications, and the Subcommittee on Natural Resources, Agriculture Research and Environment,

Washington, D.C.

The Subcommittee on Energy Development and Applications and the Subcommittee on Natural Resources, Agriculture Research and Environment met jointly, pursuant to adjournment, at 2:10 p.m., in room 2318, Rayburn House Office Building, Hon. James H. Scheuer (chairman of the Subcommittee on Natural Resources, Agriculture Research and Environment) presiding.

Mr. **Scheuer**. The Subcommittee on Energy Development and Applications and the Subcommittee on Natural Resources, Agriculture Research and Environment are holding a joint hearing today on the status and the direction of research on topics involving the Clean Air Act.

On the first day of hearings, we heard testimony on the priorities for future air pollution research and the Government's role in this research.

The second day of hearings was concerned with the proper research emphasis among pollution control, monitoring and precombustion technologies and on research regarding the effects of air pollution on health.

Today, we look forward to hearing testimony on the research and development aspects of three new issues under the Clean Air Act.

First of all, acid rain; second, indoor air pollution; and, third, pollution from synthetic fuel technologies.

I served on a U.S. delegation that went up to Halifax, Nova Scotia, this last weekend and met with Canadian parliamentarians on the subject of acid rain which is devastating their lakes and forests.

The lakes and the fishing are important to them economically, since they have a great deal of tourism, but the matter of forest products accounts for close to 15 percent of their economy. One out of every seven or eight people in Canada are employed directly or indirectly in their forest products industry.

I can tell you that the anger expressed by these Canadian members of their House and Senate could only be described as of white-heat pitch. They are angry; they are bitter; they are resentful, and they are absolutely in a state of incomprehension as to how we can let this outrage continue whereby we are decimating their lakes, forests, and crops.

I think President Reagan found when he visited Toronto early in his administration that the problem of acid rain is not only poisoning our lakes, crops, and forests and Canada's lakes, crops, and forests, but poisoning our international relations, our very diplomatic relations, with Canada.

We have two witnesses scheduled to testify. We had two witnesses scheduled to testify today who suddenly withdrew. One was scheduled to testify on indoor air pollution, and the other witness from the Department of Energy was scheduled to testify on synfuels' pollutants.

Apparently they had problems within the administration involving OMB that were not resolved satisfactorily either from OMB's point of view or from the point of view of the people who were going to testify.

I regret very much that they are not here to talk to us. I don't think they serve the interests of their administration or of the Congress, or of the country, in opting out at the eleventh-and-a-half hour, and I hope we will not have a repetition of this episode.

I want to welcome all of our witnesses today. I want to especially welcome my colleague from New York, Congressman Hamilton Fish, who is a highly dedicated, concerned Member of Congress on all issues, but especially issues that involve our national patrimony and the environment.

I would yield such time as he may need to my distinguished colleague, Congressman Ham Fish, of New York.

Mr. FISH. Thank you very much, Mr. Chairman, for those kind words.

Like you, I am pleased to welcome all the witnesses who are here today to testify on the status and direction of research and development under the Clean Air Act. I am especially happy to welcome Mr. Robert Flacke, commissioner of the Department of Environmental Conservation of the State of New York, who will testify on the subject of acid rain.

Mr. Flacke was appointed commissioner in January of 1979, and I can say from firsthand knowledge that he has performed admirably. Prior to this appointment he served as chairman of the Adirondack Park Agency, and more recently he was chairman of Governor Carey's Clean Air Act Task Force.

Commissioner Flacke has been actively involved in local government in New York State for a number of years, and he has earned a well-deserved reputation as a fair and able administrator. I look forward to hearing from Commissioner Flacke on the progress New York State has made in the important area of acid rain.

It is now clear that acid rain is doing great damage to the lakes, forests, and mountains of not only New York State, but much of the Northeast corridor of the United States. As we all know, acid rain poses an international problem, both for this country and Canada, and among a number of European nations. I am personally concerned about the environmental damage and fish kills in the Adirondacks and in other parts of the State of New York.

Acid rain is no longer a problem of the future, but one which must be controlled now. I look forward to exploring the state of our research in determining the causes of, and finding the solutions to, acid rain pollution. How close are we to being able to control these emissions? What research should be done to begin to attack this problem? What role should the Federal Government play in this effort?

I am also interested in hearing the other witnesses testifying today on new issues under the Clean Air Act. Indoor air pollution is a problem little considered in the past, which may be extremely important. In the area of pollution from synthetic fuels technologies, it is important for this committee to recognize the environmental consequences of burning fossil fuels, the most well known of which is the so-called greenhouse effect.

Gentlemen, welcome.

Mr. SCHEUER. Thank you, Congressman.

Let me just tell you, in passing, that these Canadian parliamentarians were so eager to get their view expressed and meet with American Members of Congress, that I agreed to have a day's hearing in July in the Adironacks, where we would bring our colleagues. We are going to visit lakes where fishing rods wouldn't do you any good, unfortunately.

We have two distinguished and very hard-working members of the delegation from upstate New York, Congressman Dave Martin and Congressman Don Mitchell, and they will both be here, and let me extend you a very cordial invitation to join us, and we will consult you when we select a date.

Assemblyman Stanley Fink, the speaker of the New York State Assembly, will also be involved, and it promises to be an excellent hearing.

Mr. Gregg, of New Hampshire.

Mr. GREGG. Thank you, Mr. Chairman.

New Hampshire is a small State, but there are those of us who love it. We also have a problem with acid rain, and I have to tell you that the intensity of concern expressed in Canada is found in many of the regions of New Hampshire. I hope I will be able to attend the hearing in the Adirondacks. I would hope you could consider having one in New Hampshire. It is a little farther away, but it is a place with which I am concerned.

Mr. SCHEUER. I would be very happy to ask you to participate in this hearing. That would include any of our colleagues from our sister committee jointly holding these hearings. They will be given written notice. We will give you a date as soon as we establish it, and we would be happy to have you come.

Mr. GREGG. Thank you, Mr. Chairman.

In New Hampshire, one of our primary concerns is how the task force, which is set up under the Acid Precipitation Act, is going to address the issues over the next 10 years. We are very concerned that 10 years may be too long to try to develop and identify where the problem exists and what causes the problem.

I believe there must be some decisions made before the 10 years are up as to what we can do from a research standpoint to develop systems to begin to address and abate the sulphates and the nitrates which are being emitted into the atmosphere. That is what I hope this committee would address—the specific areas where research and development can be moved forward, even though the

Acid Precipitation Task Force is in the process of reviewing all of this over the next 10 years.

Mr. FISH. Mr. Chairman, I suggest that the proceedings of the subcommittee today can be covered by a still camera and by media.

Mr. SCHEUER. There being no objection, it is so ordered.

I recognize our distinguished and very hardworking active minority member, a sometimes chairman of hearings of this committee, and hopefully a future chairman—by designation of the Democratic majority, of course—our distinguished colleague, Claudine Schneider.

Mrs. SCHNEIDER. I have a brief remark.

I am pleased to see additional attendance by members of the full committee. I think there is probably no more controversial and yet no more important issue among many that we will be discussing in this particular Congress. Certainly, when we are talking about the impact of acid rain and the limited amount of information we have about it, the proposed thrust toward increased usage of synthetic fuels, and the emphasis on other forms of energy that pose threats to our air and health, it is critically important that we hold this preliminary hearing. We know there will be additional hearings, and I congratulate the chairman for making this move, and I look forward to comprehensive testimony that we will be receiving.

Hopefully, we will be able to incorporate the testimony that will be presented today with what we have witnessed in our Subcommittee on the Environment and Natural Resources.

Thank you very much, Mr. Chairman.

Mr. SCHEUER. I appreciate our colleague's comment from Rhode Island.

I agree totally with Mr. Gregg that we cannot wait 10 years before taking some definitive action. The industry spokesmen tell us frequently there is no risk-free world and no perfect environment, and we shouldn't try to achieve that, that should not be our goal. I agree with that. On a basis of costs and benefits, the effort, whether it is in drugs or environment, or in health or in safety, to achieve that last few percent is tremendously expensive and on a cost-benefit basis, it probably doesn't pay.

On the other hand, I think we ought to follow the same logic and understanding that there is no perfect research; there is really never a time when all of the questions are answered, because, as you improve your research, as you improve the state-of-the-art, the new and improved methods of analysis, of testing, always will pose some unanswered questions.

So if we are going to wait until we have perfect answers to all of the questions, we are never going to do anything.

This is a question where we are faced with, as Grover Cleveland said over a century ago, a condition and not a theory, and we are going to have to act—and we are going to have to act on the best information we have to meet this problem in a thoughtful, cost-effective, intelligent, prudent way. But that shouldn't wait on anybody's understanding that all of the evidence is in and that we have achieved a perfect research result.

I might also say, in response to Congresswoman Schneider's remarks, that I am at a loss to understand the cut in the budget of DOE for environment research.

It seems to me that we ought to know what the effect of synfuels development, both coal and shale, are going to have on the health of our country and on our national patrimony, our environment, our lakes, our streams, our forests.

I find it absolutely incomprehensible that the administration should have cut just about $20 million out of the research budget of the Department of Energy that was to be used on research devoted to informing us as to how we can make this major thrust toward creating alternatives to Persian Gulf oil through synfuels, and yet not degrade our health or degrade our environment. We are going to have future hearings on this problem. It is a problem of deep concern to me, and I hope to you.

Are there any other colleagues who wish to make any further remarks before we hear the witnesses?

Let me say that your statement will be printed in full in the record. You might want to chat with us informally for 10 or 12 minutes, and then I am sure we will have some questions for you.

STATEMENTS OF ROBERT FLACKE, COMMISSIONER, DEPARTMENT OF ENVIRONMENTAL CONSERVATION, STATE OF NEW YORK, ACCOMPANIED BY DAVID SHAW, ASSISTANT TO THE COMMISSIONER, AND BUD HOVEY, DIRECTOR, DIVISION OF AIR, STATE OF NEW YORK, AND JAMES N. BARNES, CODIRECTOR, CENTER FOR LAW AND SOCIAL POLICY, WASHINGTON, D.C.

Mr. FLACKE. I would like to do that, Mr. Chairman.

I have submitted the testimony for the record and also copies of the State of New York's position on changes in the Clean Air Act and a recent report from the Adirondacks.

The issue of acid rain in New York State in connection with the Adirondacks is not fully understood by the people of this country. There has been rhetoric about trading off a few lakes because of the economic considerations and the creation of some type of a balance.

But you and Congressman Fish, and many others who have been closely connected with the history of New York State, know full well that the Adirondacks Forest Preserve, the creation of the people of the State of New York, over 100 years of age, with investment of billions and billions of dollars in an area as large as the State of Vermont, includes the majority of the watersheds of the State of New York. These lakes are an integral part of an area that is very closely regulated by the Adirondack Park Agency with the strictest regional land use controls in the United States of America—its purity of water, its forests, its checkerboard pattern of public and private lands.

When one talks of the decimation of a few of these lakes, in essence they are to New Yorkers talking about—well, we can live without an arm of the Statue of Liberty or perhaps take one-half of the Jefferson Memorial down.

The lakes are an integral part of the Adirondacks, and they are being slowly ruined each day.

I was given the responsibility by Governor Carey to try to work out a Clean Air Act recommendation for Congress, and yet at the same time try to determine how we could combine that with the problem that you mentioned, Mr. Chairman, and get us off of OPEC oil and be able to exist with the utilities that we have and the economy that we have, and continue the investment in the environment that we have; and I have come to some conclusions which I would like to share with you for just a few minutes as to why that problem is there and what we might be able to do with the research and development money that is available to us to reach an end perhaps before the end of that 10-year period.

First of all, one easily comes to the conclusion, after looking at the record of the Environmental Protection Agency and the method by which it was formed and the creation of the Clean Air Act and the desires and goals of Congress and the desires and goals of several administrations, it is not working as well as everyone thought it would do.

In the beginning, there was a polarization process that appeared to me to take place between the early drafters and the early staffers who had immediate input not only into the creation of EPA but the Clean Air Act. We seemed to have surrounded ourselves around 1975 to 1977 with people who had advocated that the method of cleaning up air in the United States of America was an absolute commitment to scrubbers in both old powerplants and new powerplants.

We have been arguing that issue for well over 10 years. Just as there was a group of people who thought at one particular point in the creation of our Western society that the Earth was flat, so, too, there are still some who believe that scrubbers are the panacea and the answer.

There was an advocacy for wet scrubbers, and when that didn't work, there was an advocacy for dry scrubbers. As this argument continued for a full decade between those who advocated scrubbers as the technological effort to allow us to continue to have clean air, at the same time get off OPEC oil, we found ourselves not getting off of OPEC oil, not converting powerplants, not solving, not adding scrubbers, and causing a great deal of conflict both in Congress and in the States, and with the people who are trying to manage the system.

We didn't convert; we didn't essentially add scrubbers. They still don't work very well. And all of the things that we could have done sequentially to allow us to be at this point now never did happen.

The argument remained over SO_2 for a number of years. Technology surpassed that. Whenever scientists of any repute substantially say to us, the managers and leaders of our clean air system that the real problem is SO_4, yet we continually debate the SO_2 issue.

While we argue over loadings of sulfur and percentages, the removal, and so forth, we cogently admit that small particles are essentially the problem of the future.

Modeling exercises that we felt were going to be the panacea of the management of the Clean Air Act, many times were less reliable than the wheel of chance at the church raffle. In the last few years, the State R. & D. programs have been reduced substantially.

We in the States look with a great deal of interest in the program that the Federal Government put together on acid rain because we were finding that with our limited resources over the past few years, not only were we not able to continue with the research and development efforts we had begun in New York State, but our programs had begun to fall apart because of conservative fiscal policies and the fact that we were not able to continue both management and research and development.

On a State level our research and development efforts have lagged far behind, and for that I apologize.

What do I think can be done? First of all, the 10-year investment is important. However, it should have yearly incremental reports with interim recommendations—interim recommendations that will substantially allow us to apply some of that research to the conversion of powerplants in such a manner as to maintain clean air integrity.

I would recommend that this year, research be dedicated toward an achievable, immediate goal, that is to study the social, economic, and technical problems that will be connected with NYSERDA's positions on a national coal-wash policy. A policy endorsed by NYSERDA and endorsed by the State of New York, is essentially a program that will not cause conflict between the mines, between labor, between Illinois and the Far West, and the eastern coal interests.

An immediate national policy of washing coal, over 3 percent, that would essentially say that all coal above 3 percent should be washed to the ability that it can be washed.

I recommend, also, that in order to satisfy the central mining intersts who have a large amount of high sulfur coal that may not be able to be washed down, that as much research as possible be put into the advancement and early solution to chemical washing, so that the future of our resources will lie in an environmentally sound manner, that we can use the western low sulfur coal, the central high sulfur coal and the eastern coal in an equitable manner. I believe that is probably the first step.

I also believe that the people who have been involved in the scrubber conflict should be set aside. If after 100 years we haven't been able to convince the utility interests and the environmental leaders of this country or prove to the engineering interests, I think we should consider those people who will continue to advocate scrubbers, scrubbers, scrubbers, completely, all the time, we should consider them like—we should defrock them like the outcast Jesuit. We should shun them like the recalcitrant Quaker.

We should do something with them, but we shouldn't allow them to polarize this country and this Congress and the people so that essentially we have two sides fighting with each other and no solution in the middle.

So I would advocate early on that there be some revamping in the 10-year program and some very short term early goals.

Thank you, Mr. Chairman.

[Mr. Flacke's prepared statement, the New York State position paper on the Clean Air Act, and "Acidity Status of Lakes in the Adirondack Region of New York in Relation to Fish Resources" follows:]

Good morning! My name is Robert F. Flacke. I am the Commissioner of the New York State Department of Environmental Conservation and I am pleased to be here today to testify in regards to acid precipitation. I have with me, in addition to the remarks I will make now, material which I would request be made part of the record of this hearing. For your information, I have brought with me a copy of New York State's position paper on the Clean Air Act. This paper addresses all of the issues which New York State considers important in the Act. Pages 14 and 15 are particularly related to the long-range transport and acid precipitation. We feel that if these recommendations are adopted, it will be an important step in reducing acid rain. Additionally, I have brought with me a Department publication which discusses the acidity status of lakes in the Adirondack Region. This report was published late last year and represents some of the most current information available concerning the effect that acid rain is having on the Adirondack Region of New York State.

Mr. Chairman, I would appreciate it if these documents could be entered into the official record of this hearing.

Recently, much has been said about acid rain, and a great deal has been made about the destructive effect this pollution is having on the lakes of the Adirondacks. As all of you know, New York has made the Adirondacks into a park--not an ordinary park, but a unique and exciting park that includes, protects and serves man as well as it does nature. Because of its vastness and diversity, the Adirondack Park serves varied needs of our society, contains the homes and communities of some 111,000 permanent and 90,000 seasonal residents. Through camping, hiking, canoeing, hunting and fishing, the park provides outdoor recreational opportunities of international significance to thousands who seek and benefit from its clean air and water, its unspoiled open space, its beauty and its capacity to restore peace and solitude to busy and demanding lives.

The Adirondack Park supplies important, natural resources. In particular, the wealth of its forests and the minerals from beneath its soils. It sustains an Adirondack economy based on tourism and forest products. In short, the Adirondack Park is a living park--one to enjoy, live in, and actively use.

In spite of the many efforts made to protect the Adirondacks and other natural unagricultural areas of our state, we now find that they are threatened by the pollution being addressed by this Committee which presently affects much of the eastern half of the United States.

There are several other aspects of the transport of this pollution which affect not only the Adirondacks, but all of New York. There is evidence that the sulfate aerosols may contribute to health problems and that the deposition of acids may adversely affect crops and forests. I understand that research is presently underway concerning the possible causal relationship between acid rain and die back of certain species of trees in Vermont's spectacular Green Mountain National Forest, situated immediately downwind from the Adirondacks. Research has shown decreased visibility to be correlated with a sulfate aerosol concentration. Buildings and statuary are literally defaced by these pollutants.

Last year, in response to an amendment submitted by Senator Moynihan, the Congress created an interagency task force on acid precipitation. The purpose of that legislation was to assist us in identifying the causes and sources of acid precipitation, evaluate the environmental, social and economic effects of acid precipitation; and, based on the results of the research program established by the legislation, recommend such actions as a task force deemed necessary. To New York this was an important first step to be taken by the federal government in realizing the responsibility they have to deal with this serious problem. We have long felt that a strong federal role is necessary to deal with the problems caused by acid rain. We would like to see two things happen with this program that has been established by Congress. First of all, we would hope that some of the monies which have been included in this legislation for the purposes of research would be funneled to states such as New York who have had on-going programs but now, because of increased budget constraints, have had to reduce some of their efforts in acid rain research. These funds could also be used to document the research which has been conducted by the states. I strongly believe that the answers are in and that it is time now to move ahead on dealing with the acid rain problem before the effects are so widespread that remediation is impossible.

Secondly, we would like to see the money which has been authorized for this program distributed faster than originally called for by the legislation.

Often, we are asked to justify remedies for environmental problems in economic terms. Well, there certainly is a present impact on the tourist industry and a more serious potential impact on health and property if this situation worsens. There are other values which are often overlooked. We must recognize that the environment of this continent is precious and we have a responsibility to preserve it. Throughout the years and throughout the northeast hundreds of millions of dollars have been invested by the public sector in preserving, enhancing, and making available for our enjoyment the natural resources bequeath to us by providence. Is this prodigious investment to be written off along with the health and happiness of those who are to come after us? We must demonstrate that it is not.

Thank you.

I would now be pleased to answer any questions the Committee might have.

NEW YORK STATE
POSITION PAPER ON THE
CLEAN AIR ACT

Hugh L. Carey, Governor

Brad C. Johnson, Director,
Washington Office

CLEAN AIR TASK FORCE

Robert F. Flacke, Chairman
Commissioner
Department of Environmental Conservation

David Axelrod
Commissioner
Department of Health

Paul L. Gioia
Chairman
Public Service Commission

William D. Hassett, Jr.
Commissioner
Department of Commerce

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Commissioner
Department of Transportation

James L. Larocca
Commissioner
State Energy Office

AMENDING THE CLEAN AIR ACT

I. RATIONALE FOR REVISING THE CLEAN AIR ACT

The Clean Air Act of 1970 was originally adopted because of the perception that some areas of the country were doing little, if anything, to control air pollution, while other areas were moving ahead vigorously. A basic although unstated precept was achievement of environmental and emissions equity with some allowance for states to fine tune programs consistent with the individual state's economic and environmental needs. Unfortunately, the Clean Air Act failed to achieve either of these unstated goals and, therefore, it was amended in 1977. Instead of addressing the deficiencies, the 1977 Act amendments actually created even further inequity, both through its administration and in legal and judicial interpretations.

To make the Clean Air Act a viable tool for protecting the nation's environment without causing severe economic hardships and without imposing administrative and bureaucratic impediments toward speedy implementation, the Act should be changed to correct the following deficiencies:

1) It fails to adequately address long-range transported air pollutants, such as acid rain, fine particulates and ozone.

2) It allows for - or even requires - extreme differences in control from one area of the country to another, thus creating inequitable economic differences.

3) It contains standards - i.e., PSD increments and motor vehicle emission requirements - which should be in regulations, not in law.

4) It establishes a complex mechanism - the SIP process - for dealing with pollution control that has led to administrative and procedural requirements which are time-consuming and focus on the least hazardous pollutants, while the more dangerous pollutants are almost neglected.

5) It procedurally and substantially makes conversions to alternate energy sources - especially coal and wood - difficult, if not impossible.

6) It treats new source review in non-attainment areas substantially different from attainment areas in such a way as to exacerbate the economic plight of urban areas.

7) It has been used as a vehicle for social reforms over and above those related to achievement of clean air - i.e., incorporation of basic transportation needs into the SIP approvals when the majority of basic transportation needs are related to issues other than air quality; and the requirement for transportation control measures in the name of air quality improvement which in fact produce little, if any air quality improvement but, rather, get at the root of other social and political needs which are totally unrelated to air pollution control.

II. ISSUES AND SOLUTIONS

The major issues of concern to New York State and solutions to help resolve the deficiencies in the current Clean Air Act are discussed in the attached issue papers. These are discussed primarily in the order in which they currently are addressed in the Clean Air Act, but not necessarily in the order of priority to New York State.

This document is the result of a great deal of work performed by Governor Carey's Clean Air Act Task Force, an interagency body composed of representatives from the Governor's Albany and Washington Offices, the New York State Departments of Commerce, Environmental Conservation, Energy, Health, and Transportation, the Attorney General's Office, the Division of the Budget, and the Public Service Commission.

FEDERAL GRANTS FOR AIR POLLUTION CONTROL PROGRAMS

Problem

Section 105 of the Clean Air Act provides for grants to support air quality planning and control programs, with funding being available for planning, developing, establishing, improving, or maintaining programs for prevention and control of air pollution or the implementation of national primary and secondary ambient air quality standards. A clause in this section requires that federal funds be terminated if a state cuts its share of the funds.

Solution

Amend the Act to provide for a matching formula to all state air pollution control agencies to be paid upon quarterly indications of expenditures by the agency for air pollution control programs agreed to between the state and the Environmental Protection Agency (EPA) in the annual State/EPA agreement. Assume that any cut in state funds would be matched by no more than a comparable cut in federal grant funds, not in a complete loss of the grant.

Rationale

This would protect an agency against any loss of funds, since it would still receive the same percentage of federal dollars--regardless of the amount of state or local dollars expended. It would also be assured of an adequate level of federal funding commensurate with the level of state funding. This program could be funded at 50 percent of the total expenditures of state and local air pollution control agencies and probably would not cost Congress more than is currently authorized ($87.7 million budgeted in FY 1981, with the same amount proposed in FY 1982) for air pollution grants. It would also do away with the expensive grant mechanism and bureaucracy currently set up within EPA.

New York, which receives approximately 8.4 percent of Section 105 funds, should get about $7.4 million in FY 1982, the same as in the previous fiscal year.

Background

Section 105(b) states, "no agency shall receive any grant under this section during any fiscal year when its expenditures of non-federal funds for other than non-recurrent expenditures for air pollution control programs will be less than its expenditures were for such programs during the preceding fiscal year . . . (except) . . . that a reduction in expenditures is attributable to a non-selective reduction in expenditures in the programs of all executive branch agencies of the applicable unit of government . . . ." Thus, any agency currently receiving a federal grant which makes even a one dollar reduction from a previous year's baseline is in jeopardy of losing its total grant. Only in the event of an across-the-board cut for all state agencies would the air pollution agency not lose its grant. Even then, however, it is doubtful that within any state, all agencies wind up taking precisely the same cut. In addition to the problem of cuts, Congress, in the last few years, has not appropriated adequate funds to keep up with the full needs of air pollution agencies. In some instances, some agencies have received substantial cuts in federal funds, with severe impacts on the program, while others have received an increase in funds.

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

Problem

Sections 108 and 109 of the Clean Air Act require that scientific information about the impacts of air pollution on public health and welfare be published in criteria documents along with control measures available, and that, following publication, the Administrator adopt ambient air quality standards to protect both public health and welfare. Often, the criteria documents are criticized for not using the best scientific information, especially when the Administrator reaches the point of setting the standards.

EPA staff, with the help of contractors, prepare the criteria documents, which are then reviewed by the Clean Air Science Advisory Committee, an independent review committee composed of seven members who are appointed by the Administrator in accordance with Section 109(b)(2)(A). The role of this committee, however, has been limited primarily to the review of the criteria published under Section 108. Even though the committee is established in Section 109 and has some responsibility for recommending standards to the Administrator, EPA's general counsel has determined that the committee's role is primarily limited to criteria documents and that it cannot, in fact, make recommendations on the standards to the Administrator until after he/she has published such standards for public comment.

The health standards often are perceived as being established on the basis of protection of the most sensitive individual, with a factor of safety built in. They do not truly reflect the concept of adverse health effects. The welfare, or secondary standards as they are commonly known, are designed to protect vegetation, visibility or economic damage. Most often, the secondary standard does not take into account the fact that the purpose for which the standard is designed may not be justified on a national basis, since not all parts of the country grow all types of crops or have the same types of material or visibility problem.

Those standards that are designed on a short-term basis usually may be exceeded only once each year; yet, meteorological events or natural occurring pollutant concentration may cause several exceedances during a year and thus produce a violation of the short-term standard. This is particularly true when one uses modeling to determine compliance with the standard rather than actual monitoring data, especially for new source review programs.

Solution

1) Revise the law to require a standard-setting process which would be based on protection against adverse health effects which takes into account public health risks and social and economic impacts.

2) Revise the law to require that the health portion of the criteria documents be prepared by an independent scientific group, such as the National Academy of Science. Further, require that the Administrator receive a recommendation from the Clean Air Science Advisory Committee prior to his/her formal notification of a proposal to adopt the standard. The Committee's role would be to provide scientific guidance to the Administrator on the adverse health effects and the economic and social impacts of possible standards for a particular pollutant.

3) Revise the law so that the Administrator will publish "guideline standards" for secondary air pollutants, again using a scientific committee prior to such publication so that the states may select, from the guidance, secondary standards to protect the particular elements of welfare within each individual state or air quality region, or even a portion of an air quality region.

Rationale

1) The ambient air quality standards are designed to protect public health. Almost invariably, someone doing a scientific study can find some individual who is supersensitive to the particular contaminant being studied. Use of such supersensitive individuals has resulted in EPA staff recommendations to the Administrator that the standard be established at extremely low levels, even though the majority of the population would not be affected. Most often, the supersensitive individual is affected in a minor way - not adversely, as defined in the proposed solution to this problem. It is clear, however, that the decision to opt for one standard instead of another implies a "judgment" as to how many people should be affected, and this is a form of risk assessment. Such judgments should recognize economic cost as well as public health and other types of social costs. Recognition of the economic costs to achieve greater levels of protection may make the standard setting process more rational than the present system, which bars consideration of any cost except public health costs.

2) If the Administrator utilizes an independent group, such as the Clean Air Science Advisory Committee, and follows its recommendation prior to recommending both health and welfare standards, much of the criticism of the standards can probably be averted.

3) It is necessary to provide some mechanism to allow for more than one annual exceedance of short-term standards to account for natural phenomena and rare meteorological events. This is particularly necessary because of the limitations to input data and modeling techniques, which make it unreasonable to expect

models to reliably and consistently predict short-term air quality. The models are being asked to do too much. Predicting the second highest value of a 24-hour concentration during a year at a specific location represents a frequency of occurrence of only about 0.5% and, for a one-hour standard, a frequency of occurrence of only 0.02%. We are trying to stretch models beyond reliable limits in analyzing unrepresentative conditions, such as unusual meteorological events. This placing of unrealistic demands on models causes many areas to be classified as non-attainment, even when actual air sampling data show that the area is meeting ambient air quality standards. Thus, an allowance for more exceedances of the short-term standard would correct this problem.

Most welfare effects, such as impacts on vegetation, water, wildlife, and even visibility, are local. Thus, a nationwide secondary standard may well be inapplicable in most areas of the country. The adoption of locally based secondary standards, which would take into effect the economy of the area, would seem to be a most prudent approach. Provision could be made by Congress to protect national parks and wilderness areas - i.e., those classified as Class I under the PSD requirements - by imposing on those areas appropriate secondary standards if the state fails to take action to protect such areas.

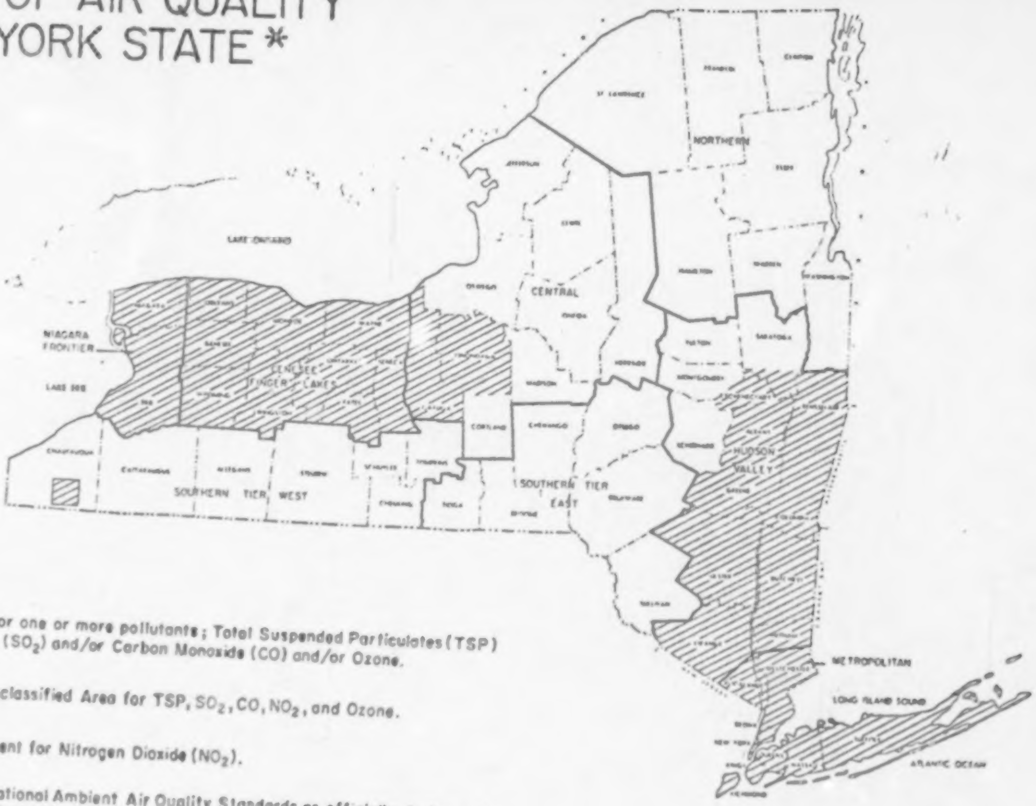
Background

National ambient air quality standards, composed of primary (protecting health) and secondary (protecting welfare) ambient standards, are meant to establish allowable pollution levels for the surrounding air. EPA sets standards for pollutants which it deems to be reasonable hazards. States are required to devise strategies for attaining the standards by 1982, although the deadline can be extended to 1987 for particularly dirty regions under certain circumstances. New York favors such flexibility for ozone, and perhaps carbon monoxide, as long as reasonable progress towards achieving the ambient goal is demonstrated.

So far, EPA has set standards for nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter, carbon monoxide (CO) hydrocarbons (HC), ozone (O_3) and lead (Pb).

All 8 regions are in compliance with the standards for NO_2, SO_2, and Pb. The particulate standard has not yet been met only by part of the Niagara Frontier, which expects to comply by 1982. The New York Metropolitan region is the only one still to comply with the CO standard, and expects to meet it by 1987 (probably sooner). The region has implemented an inspection and maintenance (I&M) program, without which it assumes compliance would not be achieved by that date. In 1981, the I&M program calls for mandatory inspection and voluntary compliance, while both facets become mandatory in 1982. Finally, the standard for ozone has not been met by three regions. These regions, with their expected compliance dates, are: Niagara Frontier (1982); Genesee-Finger Lakes (1982); and New York Metropolitan (1987).

STATUS OF AIR QUALITY IN NEW YORK STATE *


LAKE ONTARIO
NIAGARA FRONTIER
LAKE ERIE
NORTHERN
CENTRAL
GENESEE-FINGER LAKES
SOUTHERN TIER WEST
SOUTHERN TIER EAST
CORTLAND
HUDSON VALLEY
METROPOLITAN
LONG ISLAND SOUND
ATLANTIC OCEAN

▨ Nonattainment area for one or more pollutants; Total Suspended Particulates (TSP) and/or Sulfur Dioxide (SO_2) and/or Carbon Monoxide (CO) and/or Ozone.

☐ Attainment and/or Unclassified Area for TSP, SO_2, CO, NO_2, and Ozone.

Entire state is attainment for Nitrogen Dioxide (NO_2).

* As compared to the National Ambient Air Quality Standards as officially designated by the Environmental Protection Agency.

IMPLEMENTATION PLANS AND NON-ATTAINMENT PLANNING

Problem

There is considerable uncertainty as to what precisely constitutes the State Implementation Plan (SIP) for any given state at any given time, and what the legal significance of some of the elements of the SIP may be. SIP revisions may have been adopted by states but might not yet have received feder approval. In those instances, EPA says the facility is responsible for the "old" regulations, while the state may have already repealed the old regulation in favor of a new set, thus making a source responsible for following two sets of regulations which may, in some instances, be contradictory. This problem is even further compounded by the amount of time EPA has taken to approve (or disapprove, as the case may be) state SIPs. While the law clearly states that EPA has four months to review and approve, or disapprove, a SIP, EPA has consistently said that there is no time limit for approval (disapproval) of any SIP amendment. In some instances, SIPs remain unapproved for periods of years.

EPA further insists that a SIP be legally enforceable before it can approve it. Its interpretation is that all laws, rules, regulations, must be adopted before the SIP is submitted. This is rather cumbersome if EPA, for any reason, decides that it cannot accept any particular law, rule, regulation and will approve the SIP only if the regulations, etc., are changed. Obviously, the states cannot make changes without going through a lengthy hearing process, thus further delaying the SIP adoption process.

EPA often withholds approval on insignificant details. Because of these delays, new technologies or new guidelines may be adopted by EPA in the interim, and then the states are told they must meet this new guidance before the SIP can be approved. This ex post facto procedure places sources in serious jeopardy if they have moved forward at all toward meeting the state requirements.

The SIP process leaves no room for variances, either permanent or temporary, although a long-term variance could be treated as a SIP revision; however, because of the time involved in obtaining SIP approval, short-term relief is not possible under the federal system. Furthermore, variances from technological standards, such as new source performance standards, are not allowed under any circumstance except for the use of innovative technology systems.

Solution

1) Revise the law to clarify the distinction between the informational and the enforceable elements of a SIP and to limit legal enforceability to measures for which air pollution emission reduction credits are taken. Provide for recognition of broad state laws and other legal requirements without having them unnecessarily become part of the enforceable portion of the SIP, except for those portions of the laws and regulations which apply specifically to the air pollution program.

2) Modify the SIP process to require that EPA participate during the state public comment and review period in a binding way, so that duplicative hearings are eliminated and so that EPA will not second guess the states later in the hearing process following formal submission of the SIP to EPA.

3) Provide that short-term variances of up to twelve months can be granted by the states, if they meet substantive and procedural tests as established in the SIP, without need for further EPA approval.

4) Provide for deadlines on EPA review and approval action so that failure by EPA to act constitutes approval on a major SIP if action has not taken place in four months, and on any substantive SIP revision within 60 days. Further, allow states to make minor revisions to the SIP after notification to EPA without need for further EPA approval - i.e., permit conditions, variances, etc.

5) Provide that all operating permit conditions adopted pursuant to rules and procedures contained in the SIP are federally enforceable and thereby eliminate the need for individual site-specific SIP revisions for such permit conditions. This includes the "bubble."

6) Eliminate specific requirements under Section 108(f) related to motor vehicle and transit type pollution problems. Remove the requirement of Section 110(c)(5)(B)(i) related to basic transportation needs or define the term "basic transportation needs" more precisely as it relates to air pollution. Also, change Section 172 so as not to require the burden of meeting the measure contained in Section 108(f). Further, change 176 to protect the states against imposition of sanctions by EPA for EPA's failure to act on any SIP revision in a timely manner.

Rationale

1) Only those SIP requirements which specifically lead to an emissions reduction or prevent an emissions increase in the case of a maintenance plan should be enforceable by EPA. Such items in SIPs as studies or research should not be considered enforceable. Where staff or funding commitments are made, these should not be considered as enforceable items but, rather, as information items.

Often, a SIP requirement is inclusion of procedural elements which are contained in state laws and regulations having broad application. Those elements, which apparently should be enforced by EPA or under the citizen suits Section 304, should only be those portions of broad agency for which the SIP is adopted.

2) The current practice by EPA of not publishing proposed adoption of the state SIP until after the SIP has been submitted and reviewed leads to many abuses and often change because of the time delays in EPA's action. Duplicative review process would be eliminated under the solution given above, and EPA would be bound to the comments which it made in the state's hearing process. The complete record produced by the state would be made available to EPA, and it could follow the state submission with final rulemaking in a very rapid manner. This would still leave opportunity for public comment on the state proposal during the hearing process and, by having EPA testify first and preferably submitting its testimony in writing in advance of the hearing, allow for public comment on the EPA proposals, as well as on the state proposals.

3) Often, short-term variances are needed to correct the problem at a facility or source. These can be caused by breakdown or unanticipated changes - i.e., extreme cost of fuel or lack of availability of fuel during emergencies, or even water shortages such as are currently occurring in northern New Jersey and southeastern New York. Such variances should be grantable by the states on a short-term - not to exceed one year - basis; this without the need for EPA approval. Where longer term variances are necessary, or where administrative orders to correct a problem extend beyond one year, then such variances would become minor SIP revisions subject to the appropriate SIP process.

4) EPA currently takes excessive time to review and approve SIP actions. By establishing a firm deadline for EPA action, with a provision for automatic approval because of failure by EPA to act, the states will not be put in the embarrassing position of having a SIP in a state of suspended animation for months, and even years.

5) Many states have operating certificate programs, and inclusion of conditions on these permits, or certificates, provides the state with immediate administrative control. By making such conditions "federally enforceable" without going through a SIP revision process in each case, the whole air pollution control program would be speeded up and much administrative red tape eliminated.

6) The list of Reasonably Available Control Measures (RACM) in Section 108 and the requirement that they be applied in accordance with Section 172, along with the requirement for EPA to review basic transportation needs, go beyond the requirements of the Clean Air Act. Most of the RACM constitute socially desirable actions but have little, if any, impact on air quality, and in some instances, may actually negatively impact air quality. Listing these in the law, and then requiring that they be implemented, places an undue burden upon the state, which should be free to select any mix of strategies that it feels appropriate to meet the air quality standards.

Finally, the imposition of sanctions for failure to meet SIP requirements, or to have an approved SIP, is a strong tool to help force the reluctant states to move forward. However, this same tool is used indiscriminately against states which are proceeding in good faith and may be held up by EPA's lack of action on a SIP revision. Thus, the imposition of a requirement in 176 that sanctions would not apply if EPA did not act in a timely manner on a SIP would help alleviate this problem. Obviously, this provision would not be needed if EPA had a limited time to act on a SIP and if the SIP were approved upon EPA's failure to act within that time limit.

Background

The SIP is the blueprint used by a state for attaining and maintaining clean air. SIPs detail strategies to meet national ambient standards in non-attainment areas, as well as ensure "prevention of significant deterioration" in clean air areas. In doing so, a plan applies to virtually every source of air pollution within a state's borders.

Every SIP must contain, among other provisions:

-- a plan for every air quality control region not meeting primary standards, which will enable the area to meet them "as expeditiously as possible," but not later than December 31, 1982, except where extensions for transportation pollutants have been given. The plans must provide for progress toward clean air each year until standards are attained;

-- emission limits, or schedules for establishing them, requiring BACT for new sources in "clean" areas, and RACT for existing sources in non-attainment areas; and

-- a permit program for major industry and other "stationary" sources of pollution. In developing a plan, a state tallies emissions for each source in an area and develops control requirements for attainment and maintenance of standards. If necessary to meet these standards, the state can require sources to install controls that go beyond the basic requirements in state and federal law.

The state generally can determine how it plans to have an air quality control region attain the primary standard; however, as has been noted, the SIP, and every revision, has to be approved by EPA, which on occasions might approve a plan conditionally.

EPA is presently empowered to invoke sanctions against states with unapproved SIPs, including moratoriums on permits for new sources and withholding of federal grants.

FEDERAL vs. STATE ENFORCEMENT

Problem

The Clean Air Act continually provides that the states are responsible for carrying out the air pollution control programs; yet, Section 113 has been interpreted by EPA as giving the federal government primary enforcement responsibility. EPA has initiated enforcement action against sources within a state without notification to the state in advance, or, in some instances, with notification to the state but eliminating any role for state action.

Solution

Amend the Clean Air Act to allow for federal enforcement only after adequate notice - i.e., 60 days to the state and after failure of the state to initiate and actively pursue remedial action within the 60-day time period.

Rationale

The state is much more aware of the compliance/non-compliance status of sources within the state and, in those few instances where a source is temporarily out of compliance, EPA should not jump in and start an enforcement proceeding on its own but, rather, should notify the state. The state, in turn, would take appropriate action and start an enforcement program. If for some reason, the state failed to take such action, or needed EPA support, then--and only then--should EPA take legal action. Furthermore, the Section 120 non-compliance penalty program should be incorporated within Section 113 on federal enforcement and, again, state action under Section 120 should be allowed prior to EPA action.

Background

Enforcement measures are to be taken first by local and state authorities. EPA is to step in when asked for technical assistance, when state actions are deemed ineffective or when citizens have filed lawsuits alleging non-compliance with the Act.

The 1977 amendments set up two means of enforcement: civil fines, and administrative non-compliance penalties. A local enforcement official would serve a notice, with a deadline, to a non-complying source; failure to meet the deadline can result in a small fine, with EPA eventually stepping in. In this event, a federal court could levy a civil penalty of $25,000 per day per source on first-time violaters. Repeat violators can be fined $50,000 for each day a source is out of compliance.

INTERSTATE AIR POLLUTION, LONG RANGE TRANSPORT, AND ACID PRECIPITATION

Problem

Acid rain and other long range transported pollutants are beyond the control of the individual states through the SIP process, and EPA has not (and probably cannot) effectively address these problems through Section 126. In general, utility power plants with tall stacks burning high sulfur fuels are responsible for a significant portion of the problem. Many of these sources are located in the Midwest. At the same time, most of the eastern states have adopted very restrictive sulfur limits - especially in the more populated areas. Ozone is primarily caused by volatile organic compound (VOC) emissions throughout the area, which, along with ozone, are sometimes transported hundreds of miles as they react to form ozone.

Solution

1) Amend the Clean Air Act to require that all coal above three percent sulfur burned by utilities be washed (or cleaned) so as to reduce sulfur - unless such cleaning can be shown to have no effect on sulfur content of the coal. Further, require that all coal-fired utility boilers retrofit burners to reduce nitrogen oxide emissions.

2) Accelerate research toward determination of causes and effects of acid precipitation.

3) Require that all sources of VOC over 100T/yr actual emissions be required to use reasonably available control technology so as to reduce emissions.

Rationale

1) Most of the eastern United States is currently using lower sulfur fuel than the Midwest. Some oil-fired power plants will be required to convert to coal. By requiring a simple control expedient, such as coal washing, about three million tons of sulfur dioxide would be removed if the lower cut point were three percent sulfur coal.

   Where applicable, and if the systems have been fully developed, retrofit of coal-fired utilities to staged combustion would help reduce oxides of nitrogen, another component of acid rain and a component in atmospheric ozone production. While both of these are modest efforts, both in terms of reduction and cost, they are positive steps which should be taken while more research on the causes and effects of acid rain are undertaken.

2) All of the evidence on the formation, long range transport and effects of acid deposition is not yet in. Research to determine the implications of acid precipitation should be accelerated since there is every indication that the problem may be global

in nature. Research, however, should not be used as an excuse for doing nothing; therefore, some modest control measures, as mentioned above, should also be initiated.

3) Currently, VOC sources in attainment and unclassified areas are not required to have controls, regardless of size of source. As a first step, imposition of controls on all. 100T/yr or greater VOC sources will help reduce the transport problem and may make it practicable for most major metropolitan areas to meet the ozone standard with the reasonable control measures contained in current SIPs.

Background

As amended in 1977, the Clean Air Act says a state may not pollute in such a manner that will prevent attainment of primary ambient (health) standards in another state; however, EPA has not provided a regulatory framework to ensure this.

The New York State Department of Environmental/Conservation recently conducted a study of the effects of acid precipitation, and found that, as of August, 1980, almost 10 percent of the lakes and ponds in the Adirondacks region were in a critical state of acidification (pH below 5). Further, an additional nine percent are in an endangered situation (pH between 5 and 6). The State clearly believes that enough information is now known on the effects of acid precipitation to warrant instituting measures to reduce it. In this case, failure to act would be more costly than instituting measures to reduce the problem.

PREVENTION OF SIGNIFICANT DETERIORATION

Problem

Prevention of Significant Deterioration (PSD) requirements have become a formidable deterrent to new construction and to coal conversion. The regulations and administration are cumbersome, confusing, restrictive and overly expensive to meet. Time delays in obtaining approval for new facilities have been excessive. The concept of protecting pristine areas and national parks is laudable, but excesses in the name of such protection have created the problems mentioned above.

Solution

1) Amend the CAA to eliminate the incremental limits for air quality degradation in Class II and III areas, while adopting the requirement for Best Available Control Technology (BACT) on all new sources (or major modifications) 50T/yr or greater actual emissions.

2) Eliminate short-term increments for Class I areas and modify the threshold for applicability to 100T/yr actual emissions, regardless of whether new construction or modification.

3) Retain the current requirement that NAAQS cannot be violated, but eliminate pre-application monitoring and modeling except as necessary in obviously borderline cases to demonstrate that NAAQS (or Class I increments where applicable) will not be violated.

4) Limit PSD requirements only to NAAQS pollutants.

Rationale

1) The controlling factor in preventing deterioration in most Class II and III areas is usually the requirement for BACT. By eliminating Class II and III increments and requiring that all new sources be reviewed only for BACT applicability, we would be remova series of procedural steps which usually tend to delay projects. Furthermore, we would be requiring substantially the same review regardless of the location of the source - attainment areas or non-attainment areas. Sources outside of, but impacting upon, a Class I area must still meet increment requirements for such an area.

2) The areas that need protection from development and significant deterioration are unique and pristine areas. Congress has already designated those areas requiring protection as Class I. The short-term increment requirement, however, creates problems for location of facilities in such areas, or even near such areas, because of unusual and rare meteorological phenomena which must be used in modeling for short-term impacts. Furthermore, short-term impacts are transient and, therefore, not "significant deterioration." Some people argue that short-term increments help protect visibility, but if that is a problem, then adoption of a visibility standard is probably a more logical solution.

3) Pre-application monitoring and modeling are expensive and time-consuming. In most attainment areas, they are unnecessary, since the areas are usually much cleaner than the NAAQS.

4) PSD review should only be limited to NAAQS pollutants since it is inappropriate for other NSPS and NESHAPS pollutants. Furthermore, PSD Class I increments would have to be developed for every pollutant if PSD review were required, and ambient monitoring techniques established. In most cases, the non-NAAQS pollutants are emitted in small amounts on a regional or small area basis - not nationwide. To impose the same requirements for such sources will lead to excessive delays in review while decisions are made about the type of sampling to use and the acceptable ambient increments.

Background

Congress mandated PSD for areas with air cleaner than ambient standards. PSD areas are classified into one of three categories for the purpose of deciding how much deterioration should be allowed. Air which is presently better than the NAAQS is not permitted to get "significantly" dirtier. The three categories, each allowing a different amount of pollution increases, or "increments," are:

Class I--most national parks and wildernesses; very little pollution increases allowed;

Class II--all other areas are now in Class II; increment is sufficient to allow for moderate growth; and

Class III--no Class III areas yet exist; increment allows for greater pollution increases.

The increments allowed go on top of existing, or "baseline," pollution levels. An increment is not a total allowable amount of pollutant concentration, but an amount over a given baseline. The 1977 amendments applied the increment system to two of the pollutants subject to primary standards--sulfur dioxide and particulates. EPA is supposed to set increments for the other pollutants.

Presently, owners of proposed facilities large enough to affect air quality must prove through modeling and monitoring that their facilities will meet PSD requirements. PSD requires "best available control technology" (BACT) of every major new source and major modifications that will emit "significant" amounts of pollution. This technology, determined on a case-by-case basis, may not be less stringent than new source performance standards. Costs must be considered in setting BACT.

NEW SOURCES, BUBBLE AND COAL CONVERSIONS

Problem

New source performance standards (NSPS) are often counter-productive when an existing source modernizes. They require the new source or modification to meet NSPS, but old sources continue to emit pollutants beyond reasonable technology. There is also concern that coal conversions, unless done under an energy act order, will be treated as new sources--thus interfering unduly with energy independence, while not appreciably impacting on air quality.

Solution

1) Revise the Act to permit sources within an AQCR, or in the adjoining AQCR's, to trade emissions between the sources to comply with the emission requirements of a SIP, even if a "new" source. Under this tradeoff (offset) policy, the emissions from some sources would be allowed to increase when accompanied with equal or greater compensating decreased emissions from some other sources located within the same AQCR, or adjoining AQCR, provided the ambient air quality standards are maintained.

2) Revise the Act to allow that any boiler originally designed for coal may convert back to coal as long as it meets appropriate state emission standards and will not cause a contravention of ambient standards. Such sources would not be required to meet NSPS.

Rationale

1) The current bubble policy does not apply to new sources, even though they may be located next to or near existing sources. Because of the high cost of lower sulfur oil, there is an incentive for certain utilities to operate less efficient older sources which can often burn higher sulfur oil rather than run a more efficient new source which, because of new source performance standards, must burn lower sulfur but most costly oil. Also, some sources burning low sulfur oil are unable to convert to coal because of the stringent sulfur emission limitations. If all sources within the same ACQR and in the adjoining AQCR's are permitted to trade emissions, utilities could select fuels with sulfur content that would result in the same, or fewer, total emissions from all units. The bubble policy could even require a net reduction in emissions in the AQCR. As a result, costs for utility ratepayers would be lower and air quality would be improved in the AQCR. In some cases, the bubble policy will make possible the conversion of some oil burning plants to coal which otherwise may not be able to convert. The same logic applies to other types of sources.

2) Boilers which were originally designed for coal should be allowed to convert, whether voluntarily or under an energy order. However, voluntary conversions are currently required to meet NSPS which may not be necessary to meet or maintain air quality standards. Is is counter-productive to good energy management to force "scrubbers" on these conversions, especially since this cost would probably be so excessive in some cases as to prevent the conversion back to coal.

Background

The Clean Air Act calls for minimum federal emissions performance standards for new sources of pollution for a variety of reasons, including preventing states from competing with one another for new industry by relaxing pollution controls. Thus, Congress established NSPS, covering both new plants and major modifications for major polluting industries on an industry-by-industry basis. (See definitions of BACT, LAER, NSPS, and RACT.)

AUTOMOTIVE POLLUTANTS

Problem

Strictness of automotive emission standards is the primary issue. Any relaxation of federal automotive emission standards places a potentially greater burden upon the states to regulate stationary sources beyond reasonably available control technology (RACT).

Solution

If Congress gives any extension to the auto industry to meet vehicle emission requirements, then a comparable extension should be given to the states to come into compliance with appropriate ambient air quality standards.

Rationale

Most stationary sources of VOC in non-attainment areas are either under control or are about to come under control in accordance with SIP requirements. If Congress extends the time for motor vehicles to meet VOC and NOx requirements, then the states must be given a comparable extension to meet air quality standards.

Background

The 1970 Clean Air Act called for a 90 percent reduction in the pollution coming out of auto tailpipes by the mid-1970's. This goal applies to the three main auto pollutants: carbon monoxide (CO), hydrocarbons (HC) and nitrogen oxides (NOx). Though delayed in 1974 and again in the 1977 amendments for fuel economy and other reasons, the 90 percent reduction has been met for CO and HC. The NOx reduction was relaxed in 1977 to 75 percent, and was met in 1981 model year vehicles.

The limits for auto pollutants are set in grams per mile. The auto industry wants to relax the carbon monoxide limit, from 3.4 grams per mile to 7 grams per mile, contending that public health risks would not be created, while the financially troubled industry achieves great savings. New York has stated that relaxing the auto emission standards without permitting a state additional time in which to meet air quality standards will increase pressure to control industrial growth in order to achieve clean air standards.

DEFINITIONS AND GLOSSARY

* Best Available Control Technology (BACT): requirements are set by states on a case-by-case basis, and are required for all major new or expanding pollution sources in "clean air" regions. Costs must be considered in setting BACT, which may not be less stringent than new source performance standards.

* "Bubbling": a policy in which an imaginary bubble is drawn around an entire plant or region; the company or region must find the most efficient way of controlling the plant's/region's emissions as a whole. As long as no more emissions escape from the overall bubble than before, innovation can continue.

* Increment: a graduated scale of allowed pollution increase for each class (Class I, II, and III--see Prevention of Significant Deterioration). It is not a total allowable amount of pollution concentration, but an amount over a given baseline. This provides for some industrial growth in areas with air cleaner than the national ambient standards.

* Inspection and Maintenance (I & M): a program which calls for annual inspections of automobiles in order to check for excess emissions. When excess emissions are found, the owner must have the vehicle repaired. States which seek compliance extensions for automotive pollutants, such as carbon monoxide and ozone, must utilize measures which will ensure compliance by the extended date; I & M is an example of such measures.

* Lowest Achievable Emission Rate (LAER): requirements are set by states on a case-by-case basis, and are required for major new or expanding sources in areas which do not meet federal ambient air standards. LAER, which is set without regard to cost, is defined as either the most stringent emission limitation contained in the implementation plan of any state for a category of sources, or the most stringent emission limitation demonstrated within an industrial category.

* Modeling: scientific computer technique used to project increased emissions from new sources of air pollution and their impact on ambient air quality and compliance with ambient health standards.

* Monitoring: actual ambient air quality at representative sites is sampled to determine pollution levels and compliance with standards.

* National Ambient Air Quality Standards (NAAQS): are composed of primary (protecting health) and secondary (protecting welfare) ambient standards, which are meant to establish allowable pollution levels for the surrounding air. The deadline for states to meet primary standards is 1982, although states can receive extensions to 1982 in areas where automobile-related pollution is severe. There are no deadlines for secondary standards.

* New Source Performance Standards (NSPS): are set by the Environmental Protection Agency for industrial categories, forming the minimum for major new or expanding pollution sources. Costs must be considered in seting NSPS.

- * Non-Attainment: regions with air pollution which violates primary standards are designated as "non-attainment." Most of the 247 air quality control regions in the Untied States are non-attainment areas for one or more of the primary pollutants. These dirty air regions are subject to strict controls to bring them into compliance with the health standards.

- * Offsets: a new source in dirty air regions must ensure that an existing source reduces its emissions by at least the same amount as the emissions to be yielded by the new source.

- * Prevention of Significant Deterioration (PSD): mandated by Congress for areas with air cleaner than ambient standards, PSD areas are classified into one of three categories for the purpose of deciding how much deterioration should be allowed.

Class I:	most national parks and wildernesses; very little pollution increase allowed;
Class II:	all other areas are now so classified; increment is sufficient to allow for moderate growth;
Class III:	no such areas yet exist; increment allows for greater pollution increases.

- * Reasonably Available Control Technology (RACT): requirements are set by states on a case-by-case basis, and are required for many existing polluters in areas which do not meet federal ambient air standards. Costs must be considered in setting RACT.

- * State Implementation Plans (SIPs): plans developed by states to spell out the detailed strategies for meeting the primary standards. SIPs are subject to approval by the Environmental Protection Agency.

- * Types of Pollutants: The Environmental Protection Agency has established primary and secondary standards for seven pollutants:

  1) carbon monoxide (CO): automobiles are the main source of CO, a colorless, odorless gas which can cause dizziness, unconsciousness, and death in extreme concentrations by depriving the blood of oxygen. Its concentration is greatest where there is heavy traffic in confined areas. Areas with extreme auto pollution can get extensions until 1987 to meet the CO standards.

  2) hydrocarbons (HC): these pollutants are the product of incomplete gasoline combustion and fuel evaporation, and come from both automobiles and industry. HCs react with nitrogen oxides to form smog. Scientific studies show that some HCs are toxic but most are not.

3) lead (Pb): emissions come primarily from anti-knock agents in gasoline, as well as from the lead industry. Lead pollution can affect the kidneys, and the nervous and blood-forming systems, and may cause learning disabilities in young children, according to EPA.

4) nitrogen dioxide (NO_2): this pollutant is a byproduct of industrial processes. Some 40 percent of all NO_2 comes from automobile emissions. According to EPA, nitrogen oxides can lower body resistance to some respiratory infections and can increase lung disease. NO_2 contributes to ozone formation, and is most prevalent in industrial regions, plus wherever there is heavy traffic.

5) ozone (O_3): formed in sunlight when nitrogen dioxide reacts with hydrocarbons and other chemicals in the air to create smog. Ozone primarily causes respiratory problems, according to EPA, ranging from coughing to impairment of lung function. It can also increase susceptibility to heart disease. Areas with extreme auto pollution can get extensions to 1987 to meet primary standards for ozone, when they agree to undertake strict measures to clean up ozone pollution. Ozone pollution is caused by both stationary sources and automobiles.

6) sulfur dioxide (SO_2): a corrosive gas emitted during coal and oil combustion and other industrial processes. SO_2 has the unpleasant odor of rotten eggs and is associated with colds and aggravation of asthma and bronchitis, according to EPA. The major emitters are fuel-burning industries, utilities, and heating capacity. In addition to damage to the respiratory system, lung and heart conditions can result. SO_2, which can corrode iron and steel, combines with other pollutants in the atmosphere and can return to the earth as acid precipitation. It also contributes to visibility problems. SO_2 levels are highest in highly industrialized regions of the country, like the Northeast. But these emissions are also present wherever industry exists, including rural areas.

7) total suspended particulates (TSP): these are basically dust and liquid particles from industrial plants, heating boilers, automobiles, and roads. Large particulates can clog the lung sacs, says EPA. The smaller particles can carry other toxic substances into the deep lung and bloodstream. TSP can also create visibility problems. Particulate problems are more acute in industrialized regions.

Acidity Status of Lakes in the Adirondack Region of New York in Relation to Fish Resources

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Abstract

Many surface waters in the Adirondack region of New York State have low alkalinities due to a carbonate-poor geology. This condition makes these waters particularly sensitive to the high acid ion deposition associated with the region's airshed.

Since 1975, pH and alkalinity measurements have been made on 849 ponded waters throughout the Adirondack region to determine the scope of water quality impacts associated with acid ion deposition and to provide a baseline inventory for indexing future measurements. The present condition of surface waters is described on the basis of summertime, one meter depth, pH measurements obtained with a pH meter under air-CO_2-equilibrium conditions. Twenty-five percent of the waters in the survey registered pH readings below 5.0. These waters comprise 10,460 surface acres.

Comparisons of historic and post-1974 acidities are made where data points from comparable methodologies exist. Relationships between meter pH, colorimetric pH, alkalinity, conductivity, calcium, lake surface area, lake surface elevation and geographical location are discussed. Changes in fish species composition and sportfishing yields observed in waters exhibiting increased acidity are reviewed.

Description of Adirondack Lake and Pond Resources

As a result of extensive glacial activity, the Adirondack region of northeastern New York State contains a vast and varied ponded water resource. The most recent count adapted from a 1979 inventory of the Adirondack ecological zone (Pfeiffer 1979) reveals that there are approximately 2,877 individual lakes and ponds, encompassing some 282,154 surface acres. The New York State portion of Lake Champlain, 97,000 acres, is purposely excluded from this summary since its low elevation waters are not considered to be representative of the Adirondack uplands. Average size of ponded waters included in this inventory approaches 98 acres and ranges from those of less than one acre to 28,000 acre Lake George. Figure 1 delineates the boundaries of the Adirondack ecological zone in northern New York State. This zone perimeter is derived from a modified 1,000 foot elevation contour but includes Lake George and Sacandaga Reservoir. Appendix Figure 2 depicts the Adirondack region overlain with 15 minute U.S.G.S. quadrangle map outlines.

Wilderness Concepts and Types of Fisheries

In comparison to other areas of New York State and the northeast, the Adirondack Mountain region (Figures 1-3) is relatively undeveloped and sparsely settled by permanent residents. Article XIV, Section I of the New York Constitution is intended to protect the quality of waters within the forest preserve. More recently, the State and private land use constraints imposed by the State Land Master Plan and Land Use and Development Plan are designed to further maintain the wilderness character of the Adirondack Park. As a result, much of the Adirondack water resource is eminently qualified to provide the requisite scenery, solitude and preferred fish for a "quality" wilderness fishing experience. To many an urban resident, this chance to participate in and enjoy his or her sport in relative isolation is the prime attraction which sets the Adirondacks and its fisheries resources apart. Also, the great number and variety of available waters permit a wide spectrum of diversity and choice in angling opportunities.

For purposes of program administration, the fish management activities in New York State have been broken down into several subprogram areas which represent "classes" of waters and describe types of fisheries. The "classes" of ponded waters having direct relevance to the Adirondack scene are listed by frequency and acreage in Table I. One of the most characteristic and numerous types of ponded waters encountered in the Adirondacks is brook trout ponds. In the recent past, this "class" of waters has been the one most affected by acidification. Many of these waters are small headwater ponds located at high elevations. It is ironic that many of these remote wilderness waters which have been so well protected from conventional sources of pollution have, due to their location, become the victims of atmospheric acidification.

Other types of fisheries represented by the five remaining "classes" of waters include two-story lakes, coldwater ponds, warmwater lakes, unknown (unclassified) ponds and acidified ponds (Pfeiffer op. cit.). Unknown (unclassified) ponds are Adirondack waters which could not be assigned to one of the preceding "classes" due to a paucity or complete lack of survey information. Similar to brook trout ponds, many of these unknown ponds also lie at relatively high elevations and, thus, are presumed susceptible to acidification. To date, and including some naturally acid "bog" type waters, we have identified 264 Adirondack ponded waters, representing about 11,518 acres, which register summer surface pH values below 5.0 and are no longer considered capable of supporting viable fisheries. Most of them are vulnerable, former brook trout ponds. A cut-off point which considers waters having a summer surface pH below 5.0 is a somewhat arbitrary measure of "critical" acidification status. However, in our experience, this breakpoint appears to coincide fairly well with losses of even the more acid-tolerant fish species, such as brook trout.

Geology and Environmental Limitations

In terms of bedrock geology, the Adirondacks are the southernmost extension of the vast pre-Cambrian shield. The soils are predominantly shallow, stony and relatively infertile. Most of the surface waters exhibit low alkalinities and pH values which fall in the acid range of the pH scale. These conditions reflect the dominance of well weathered metamorphic and igneous rocks, represented by gabbro, syenite, anorthosite, gneisses and schists. Limited outcrops of calcite marble provide localized oases of fertility in this generally unproductive environment. The Adirondacks are also unique in that they exhibit specific historical, physical, chemical and biological characteristics which diverge widely from other physiographic regions of New York State. Along with obvious differences in bedrock geology, as illustrated in Figure 4, accompanying infertile soils, low solar radiation and a relatively short frost-free period, the nutrient-poor Adirondack waters exhibit low natural ion content. Values for calcium (Appendix 1), magnesium and bicarbonate are particularly depressed and account for the soft waters which characterize the aquatic environments. These factors contribute to the poorly buffered condition of many Adirondack waters which makes them particularly vulnerable to acidification. This susceptibility is compounded by their heavy annual precipitation load and downwind location from significant sources of air pollution.

Background of Lake Acidification Studies in the Adirondack Region of New York State

As recently as ten years ago, there were probably only a handful of atmospheric scientists and ecologists in New York State who were even aware of the acid precipitation problem. However, by the mid-seventies there was a veritable literature explosion on this subject, accompanied by greatly expanded research and inventory efforts by fisheries-oriented investigators. Admittedly, some Adirondack fisheries workers were aware of acidification and associated losses of fish populations in the early 1950s but the relationship to atmospheric pollution was not widely established until Scandinavian and Canadian-based literature demonstrated the connection.

A milestone in Adirondack lake and pond acidification studies was placed in the early summer of 1975. Dr. Carl Schofield of Cornell University, in cooperation with Regional DEC fisheries staff, undertook a comprehensive water chemistry and fish survey of 214 high elevation ponds (Schofield 1977). This project was largely financed by Dingell-Johnson funds and was limited to waters of 2,000 foot elevation or more. The survey indicated that fifty-two percent of the waters sampled exhibited surface equilibrium pH levels below 5.0 and only seven percent were in the pH range 5.5-6.0, which corresponds to the area of minimal buffer intensity and acid neutralizing capacity. It was suggested that the acid conditions observed in many Adirondack lakes logically resulted from atmospheric acid loading with sulfate representing the major anion present. Elevated concentrations of aluminum, manganese and zinc were also found in acidified lakes and increased concentrations of these metal ions, at low pH, were suspected of synergistic increases in toxicity. Additional research conducted by Dr. Carl Schofield in 1974, 1975 and 1976 revealed the role of increased atmospheric deposition of nitrate as well as the occurrences of brief, but severe, pH depressions associated with episodes of snowmelt.

While New York State helped pioneer the biological survey concept in the 1920s, the acidification crisis of the 1970s pointed out the relative paucity and poor quality of some of the historic and recent survey data in respect to standardized chemical techniques for determining pH and alkalinity. The original biological survey pH methodology, employed from 1926 to 1939, utilized the Hellige color comparitor but only a fraction of the waters in each watershed were actually analyzed. Similarly, the methyl-orange methodology was employed for alkalinity determinations but, again, only a percentage of waters in each watershed were actually sampled. Following World War II, State fisheries personnel were also equipped with either field or laboratory electronic pH meters but the exact test procedures employed were rarely recorded. Field pH meters were frequently subject to breakage or malfunction and even recent models have proven unreliable under rigorous field conditions. With the advent of the "Hach" kit, many units abandoned their fragile field pH meters and again resorted to the less accurate colorimetric technique. "Hach" alkalinity kits gradually replaced the methyl-orange, phenolphthalein methodology but, in many instances, alkalinity measurements were simply not taken.

In light of the growing awareness of the acidification problem and the need for more standardized techniques in the mid-seventies, Dr. Carl Schofield began drafting detailed guidelines for survey and monitoring acid-sensitive waters in New York State (Schofield 1978). They outlined standard operating procedures for detection of trends in water quality and fish population status.

Summary of Post-1974 pH-Alkalinity Measurements and Relationships

The year 1975 was selected as the cut-off point for describing current Adirondack lake acidity status referred to in this report. With the ongoing acidification problem, it was felt that older data might be too stale for describing current conditions and the 1975 comprehensive survey produced the first large up-to-date data base founded on accepted procedures for determinations of pH, alkalinity and conductivity. Regional DEC fisheries crews have also been operating under similar guidelines in connection with comprehensive fish and water chemistry surveys and long-term monitoring waters surveys, since 1975. Another significant source of contemporary water chemistry data resulted from an Indiana University project conducted by Don Charles in the summer of 1978, when some 50 geographically diverse Adirondack ponded waters were sampled. The Bureau of Fisheries Lake Acidification Studies Unit, formed in 1979, conducted an extensive water chemistry survey of 396 waters via helicopter in that summer.

Chemical analyses for the 1979 extensive survey were completed at the DEC laboratory in Ray Brook. Results are reported as the mean of duplicate pH determinations run under air-CO_2-equilibrium conditions achieved by aeration of the samples via an air pump and gas dispersion tube. Similarly, duplicate acid titrations were run for alkalinity determinations with the sample under continuous aeration. Each sample was titrated in a step-wise fashion by adding increments of 0.1N hydrochloric acid from a calibrated piston transfer pipette with disposable polypropylene tips. The sample was allowed to reattain pH equilibrium after each increment of acid was added and the pH was then recorded down to the titration of pH 3.5. Alkalinity was determined by regression of Grans plot titration pH's and cumulative acid volumes. Procedures for pH and alkalinity determinations are outlined in Appendix II.

Summer surface (1 meter depth) pH values encountered in the 849 Adirondack waters surveyed between 1975 and 1979 are summarized by 0.1 pH unit groups in Figure 5. These ranged from a low of 3.5 to a high of 10.0 with the mean hydrogen ion concentration corresponding to pH 4.93. Since the logarithmic basis for the pH scale greatly accentuates low values, it may be more reassuring to weight this calculation on the basis of actual acreages involved and derive a more representative mean hydrogen ion concentration corresponding to pH 5.48. We have adopted a pond acidification status classification which considers waters exhibiting a summer surface pH above 6.0 as being in a satisfactory condition. Those exhibiting a summer surface pH between 5.0 and 6.0 are considered "endangered" while those demonstrating readings below 5.0 are declared to be in a "critical" state of acidification. Figure 6 describes the acidity status, by acreage, of the Adirondack ponded water resources based on post-1974 measurements. Obviously, this rating system is somewhat simplistic since other factors, such as dissolved metals toxicity, episodes of snowmelt pH depression and the effects of biological activity and recent rainstorms, all compound the picture. Nevertheless, we feel that this type of grouping does provide us with an estimate of acidification status, consistent with observed fish distribution, which can serve as a crude baseline to detect future trends. Results of the 1975-1979 summer surface pH data summaries shown in Table II indicate that 25 percent of the numbers and almost five percent of the acreage of waters sampled were at the "critical" level. This emphasizes the fact that most of impacted waters are relatively small.

This phenomenon is more clearly depicted in Figure 7 where lake surface area increments are matched against percent acreages within pH ranges. The highest percentage of "critical" pH values is found among smaller waters. The inverse relationship between the surface acreage of Adirondack ponded waters and their vulnerability to "critical" acidification is related to the headwater location of many of these smaller ponds.

A distinct positive relationship was observed between lake surface elevation and "critical" pH readings for the 1975-1979 survey sample.

This phenomenon is illustrated in Figure 8 where lake elevation ranges are matched against percentages of area within pH ranges. The higher elevation waters demonstrate the highest percentage of critical pH values. The positive correlation between increased elevation and reduced pH logically reflects the combined influence of heavier precipitation load, the smaller surface acreage and watershed size, which characterizes most headwater ponds, and the prevalence of granitic bedrock and shallow soil deposits.

Severity of the lake acidification problem varies considerably within the Adirondacks. The geographical distribution of impact, by 15' U.S.G.S. quadrangles, is illustrated in Figure 9. The pH ranges encountered in the acreage of water sampled in each quadrangle during the 1975-1979 time-frame are depicted in individual pie charts. Although the distribution and intensity of sampling varied between quadrangles, problem areas in the west-central and southwest regions are readily discernible. On the other hand, the eastern perimeter of the Adirondack region is much less impacted. Differences in annual precipitation levels (Figure 10) appear to exert a substantial influence on the geographical distribution of impact within the Adirondack region.

Some acid rain researchers think that alkalinity determinations are a better indicator of lake acidification status than pH, particularly when the Gran titration technique is employed to obtain the former parameter. One of the problems associated with pH determinations relates to the influence of primary production on diurnal CO_2 levels. Also, single surface samples may not be representative of the entire water column. They are generally higher, unless influenced by a recent rainstorm, in which case they may be significantly lower. Nevertheless, we purposely selected broad pH ranges to categorize acidification status because of the relative paucity of historic alkalinity data. In addition, our current analysis results indicate a generally good correlation between these two parameters for daytime, summer, surface readings under air equilibrium conditions (Figure 11). To adjust for the potential variability in pH readings, we have adopted the concept of using broad ranges rather than emphasizing precise individual values in classifying waters.

Figure 12 illustrates three categories of total alkalinities encountered in the 1975-1979 time-frame sampling effort. These ranged from a low of -109.9 to a high of 1,132.3 ueq/l with a mean value approaching 131.1. However, when this calculation is weighted on the basis of acreages within alkalinity ranges, the mean is elevated to 168.7 ueq/l. For Adirondack conditions, we have adopted a total alkalinity value of 10 ueq/l as the cut-off point below which "critical" acidification is interpreted from summer surface (1 meter depth) alkalinity measurements. The category ranging from 11 to 50 ueq/l corresponds with the "endangered" fraction while values in excess of 50 are considered to be "satisfactory".

Figures 13-15 portray relationships between total calcium and alkalinity, total Ca-pH and pH-conductivity. These illustrate regressions derived from a 1979 survey sub-sample of 100 Adirondack lakes.

As expected, there is a close correlation between calcium concentrations and total alkalinity with zero or negative alkalinity values generally occurring when total calcium levels fall below 2 mg/l. Likewise, pH values of less than 5.0 are generally associated with total calcium concentrations below 2 mg/l. On the regression curve developed for 100, 1979 samples, pH 5.0 corresponds with calcium concentration of 1.62 mg/l and pH 6.0 with a concentration of 3.72 mg/l.

The relationship between pH and conductivity was not as strong. Waters exhibiting conductivities between 20 and 30 mmho/cm had pH values ranging from less than 4.0 to above 6.5 units.

In general, waters which have been lost to fish production can be characterized as having a pH below 5.0, total alkalinity below 10 ueq/l, conductivity below 40 mmho/cm and calcium concentrations below 2 mg/l. Lakes and ponds exhibiting pH below 6.0 had alkalinities of less than 50 ueq/l and calcium concentrations below 4 mg/l.

The relationship between mean equilibrium laboratory meter pH values and laboratory colorimetric pH readings for a set of 1979 samples is presented in Figure 16. Within the acid range, the colorimetric (Hellige comparitor) readings were consistently higher than the meter determinations. This disparity is most pronounced at the lower end of the pH scale and helps confirm a long-standing opinion that the colorimetric methodology is biased in favor of elevated readings which are most widely divergent in waters which lack buffering capacity.

The relationship between historic colorimetric (Hellige comparitor) and current colorimetric pH readings is presented in Figure 17 where pH distributions are compared for waters in the 1979 sub-sample for which historic data were available. Historic readings obtained in the 1930s were generally higher than comparable current determinations for the same group of waters. This reflects a general deterioration of water quality during the 40-year time frame between samplings. Today, using the identical Hellige colorimetric pH methodology, we have many more readings below 6.0 than were encountered in the 1930s. Figures 18-20 also illustrate the shift in Hellige pH distribution observed from the 1930s to 1979 for a sub-sample of Adirondack waters. Again, there are more waters in the lower pH ranges today.

Impact on Fisheries

As indicated previously, acidification effects related to atmospheric pollution have exerted the greatest negative impact on former Adirondack brook trout ponds. This is not because brook trout are particularly sensitive but rather because they were frequently the only game fish species resident in many vulnerable, small, high elevation habitats. Schofield's 1975 comprehensive water chemistry and fish survey, (Schofield op. cit.) limited to high elevation waters over 2,000 feet, revealed that 82 percent of 111 waters exhibiting a surface pH of less than 5.0 were devoid of fish life. Current resource inventory estimates indicate that at least 180 former Adirondack brook trout ponds, representing some 7,130 acres, have succumbed. Due to an ongoing modest liming program, about 672 acres within the acidified category are currently viable but would undoubtedly revert to their acidified status if periodic lime treatments were terminated. Despite liming efforts, the prognosis for the immediate future does not appear very optimistic and ongoing atmospheric acidification will undoubtedly continue to plague this resource.

One hopeful element relates to the recent (post-1977) substitution of more acid-tolerant Temiscamie x domestic brook trout hybrids, and/or their backcrosses, in routine fall fingerling pond stocking programs. The possibility that this superior hybrid may be providing some immediate benefits is borne out in the case history of Spruce Lake. Fish populations in this remote body of water have been checked periodically since 1934 and a variety of native fish species were encountered up to 1976. These included brook trout, lake trout, white sucker and golden shiner. Very recently, some "critical" pH readings have been documented and a 1979 gill-netting survey collected only brook trout. These fish, however, included at least three age classes with excellent representation among the youngest age group. A marking program has been initiated to positively substantiate the contribution of hybrid plantings. The fish survey record for South Lake also demonstrates a progressive loss of resident native fish species which appears to be symptomatic of the acidification phenomenon. This water is even more severely impacted than Spruce Lake and past plantings with several pure wild strain and one hybrid strain of brook trout failed to maintain a viable fishery. Case histories for South, Spruce and several other impacted waters are provided in Appendix III.

Comprehensive fish surveys conducted in 1979 sampled a total of 52 waters. Unlike the aforementioned 1975 survey, these waters were not limited to 2,000 foot, and over, elevations. Sampling was accomplished via Swedish nylon multifilament gill nets and minnow traps. The choice of sampled waters was not based on a randomized selection process and the results obtained do not, in themselves, describe the overall relationship of fish presence in respect to pH ranges. They do correlate well, however, with previous findings and provide an example supporting the acidification classification scheme we are employing.

Results were that 46 (88%) of the test-netted waters contained at least one species of fish. These waters exhibited summer surface pH readings ranging from 4.81 to 7.00 but, in the case of the lowest reading, only a single brook trout specimen was recovered from a springhole. Conversely, six (12%) of the sampled waters did not yield any fish life and their surface pH readings ranged from an extreme low of 3.54 to a high of 6.00.

When fish recovery data is matched against pH ranges, we find that three waters (6%) of the total sample exhibited surface pH values below 5.00 and only one of these waters yielded fish life in the form of a single brook trout specimen. In the intermediate pH range, between 5.00 and 6.00, there were 24 waters, 46 percent of the sample, and 86 percent of these contained at least one species of fish. All of the 25 waters, 48 percent of the sample, exhibiting pH values above 6.00 contained fish life.

Among the 46 waters supporting some type of fish life, 41 (89%) contained one or more species of coldwater game fish. Brook trout were collected in 40 waters, lake trout in three, rainbow trout in three and brown trout, splake, landlocked Atlantic salmon and kokanee, each in a single water. Three waters (7%) contained a warmwater game fish in the form of smallmouth bass. Among the latter, one water was in the intermediate pH range while two waters were in the range above 6.00.

Canadian researchers (Beamish et al. 1975) have documented the fact that several warmwater fish species, including smallmouth bass and walleye, are particularly intolerant of acidification and noted reproductive failure. Table III shows where some warmwater fish species losses are expected to occur in respect to the pH scale. In the Adirondack region, a number of former bass lakes, including Woodhull Lake, Big Moose Lake and Canada Lake have lost their smallmouth populations in the recent past and reproductive failure associated with increased acidity is suspect. Similarly, several other marginal pH bass waters, including Cranberry Lake and Tupper Lake, appear to be suffering marked population declines.

Of the waters exhibiting pH below 5.00 in the 1979 extensive water chemistry survey, about 23 percent by number and 33 percent by acreage represented potential losses of warmwater fisheries. This is probably a minimal estimate where sensitive species such as black bass and walleye are involved. Thus, while our initial concern with the acidification problem emphasized the loss of Adirondack brook trout ponds, it appears that vulnerable warmwater habitats and food chains are also being lost or endangered.

Sportfishing yields in several impacted waters have been eliminated and presumably reduced in marginal waters where sensitive species occur. Comprehensive Plan for Fish Resource Management Within the Adirondack Zone, Pfeiffer (op. cit.) estimated an overall average yield for Adirondack ponded waters approaching five pounds/acre/year. Our latest updated resource inventory determined that nearly 11,000 acres of water have reached the "critical" state of acidification. Since much of this acreage represents remote former brook trout ponds, it is considered likely that both angling pressure and resulting yields would have been considerably below the Adirondack Zone average and a reduced yield expectancy of two pounds/acre/year is postulated. This exercise generates an estimated loss in yield of some 22,000 pounds per year which can be attributed to atmospheric acidification. Spin-offs associated with this decline logically include loss of recreational opportunity as well as negative impacts on the ecology and economy of the area.

Recommendations and Information Needs

In response to the acidification dilemma, the Bureau of Fisheries of the NYS Department of Environmental Conservation has embarked on an acid waters management program which includes the following elements:

1. Long-term monitoring waters surveys, both winter and summer (six study lakes).
2. Computerization of existing and updated lakes and pond survey data.
3. Mapping of waters by their state of acidification.
4. Comprehensive fish and water chemistry surveys (60 waters in 1980).
5. Extensive water chemistry surveys (100 ponded waters and 600 stream stations on 160 streams in 1980).
6. Pond liming (at least 3 to 6 waters).
7. Refuge liming research under contract to Cornell University.
8. Research on performance of acid-tolerant brook trout strains under contract to Cornell University.

Successful implementation will enhance our position to determine the true impact of surface water acidification on Adirondack aquatic resources and also develop or maintain short-term mitigative measures to help combat this insidious threat. The latter includes continuation of both routine and experimental liming programs to assist in answering the information needs: "Under what conditions is liming an economically defensible technique?" Similarly, continued interim production stocking of currently available, acid-tolerant brook trout strains and research on selective breeding for increased tolerance will help answer the question: "Can the stocking of acid-tolerant strain fish pay sufficient dividends in increased survival to justify the costs?" There is also a pressing need to address the problem of acid precipitation's effect on the mobilization of metals such as mercury, cadmium and aluminum.

A primary information need of the Bureau of Fisheries is to determine relative "breakpoint" models for maintaining various fish species and fish species associations in Adirondack waters. This information would be of immediate use in (1) interpreting observed changes in fish species composition; (2) predicting fish population impacts from water chemistry data thus leading to prioritization of future surveys; (3) identifying indicator species whose occurrence or loss may precede the collapse of sport fish populations; (4) adjusting stocking policies for salmonids, walleye and tiger muskellunge to avoid planting in unfavorable chemical situations; (5) better assessment of overall acid precipitation impacts on fish resources to help answer the question: "At what point in time can we expect to lose viable species-specific, fisheries from any given water?"

While considerable progress has been made toward describing the current chemical status of Adirondack waters, efforts to document the impact of increasing acidity on fish stocks have lagged due to manpower limitations. The labor intensive task of surveying lakes and ponds to determine population densities, species and age-class composition has fallen primarily on the already understaffed Regional DEC fisheries units. This situation has prohibited a current assessment of the overall status of a number of important fish species, especially warmwater species in many larger waters. For example, of 28 Adirondack waters historically containing walleye, only four have been surveyed since 1974. There is a need to field at least three more survey teams to bring this effort up to acceptable levels.

Obviously, the ultimate solution to the problem is out of the fisheries managers' domain and relates to the rapid development and employment of control technologies and acceptable energy alternatives on an international scale. There will be no solution without difficult political decisions stimulated by public interest and demand. Resource agencies, such as the Bureau of Fisheries, must provide facts and inform the public. We can only hope that an enlightened public will be responsive to stopping acidification in time.

ACKNOWLEDGEMENTS

Development and completion of this report would not have been possible without the cooperation and assistance of many individuals. Mr. Carl Parker, Chief of the Bureau of Fisheries and Dr. Paul Neth, Inland Fisheries Supervisor, provided helpful guidance and editing in developing the document. We are particularly indebted to the Technicians assigned to the Lake Acidification Studies staff, including: Mr. Robert Bonham, Mr. John Feurer, Mr. Vance Gilligan and Mr. Daniel Moore. Also included to this category is S.U.N.Y. Syracuse University intern Mr. Jeffrey McGrew and Syracuse University volunteer Mr. Alan Dingman. Regions 5 and 6 Regional Fisheries Managers, Mr. Leigh Blake and Mr. Gene Lane, and their respective staffs made a heavy contribution, especially Senior Fish and Wildlife Technician Mr. Raymond Brown and Senior Aquatic Biologist Mr. James Coutu. Conservation Biologist, Mr. Gerald Barnhart, was also most helpful. S.U.N.Y. Syracuse University intern Mr. Bernard Zahn was responsible for developing many of the Figures and Tables associated with this document as was Senior Draftsman, Mrs. Barbara Scouten. The Audio-Visual Unit in Albany, under the direction of Mr. Robert Rehbaum, prepared the final graphics. Mr. George Furman's assistance was essential in this task.

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Table I. Inventory of Ponded Waters in the Adirondack Regions*, Depicting Types of Fisheries by Classes of Water

Classes of Waters	Number	Acres
Brook Trout Ponds	512	28,408
Two-Story Ponds and Lakes	65	102,163
Coldwater Ponds and Lakes	72	5,655
Warmwater Ponds and Lakes	437	112,869
Unknown (Unclassified) Ponds and Lakes	1,527	21,541
Total	2,613	270,636
Known Acidified Ponds and Lakes		
Limed Acid Ponds**	16	672
Known Naturally Acid Ponds***	36	386
Post 1974 Acidified Ponds	212	10,460
Total	264	11,518
Grand Total	2,877	282,154

*Modified from inventory of waters within the Adirondack Ecological Zone as originally described in: "A Comprehensive Plan for Fish Resource Management Within the Adirondack Zone", August 1979.

**These waters are presently viable but would revert back to their acidified state if periodic lime treatments were terminated.

***Some Adirondack ponds were known to be acidic prior to recent surveys. Most are presumed to be "naturally" acid due to organic acids associated with bog shoreline areas.

Table II. Subsample of Adirondack Region Ponded Waters for Which Post-1974 Summer Surface Meter pH Data is Available, Showing pH Ranges

Acreage

pH Range	Acres	Percentage of Total Acres	Acidification Status
less than 5.00	10,460	4.7	critical
5.00-6.00	63,243	28.4	endangered
above 6.00	149,021	66.9	satisfactory
	222,724		

Number of Lakes and Ponds

pH Range	# of Waters	Percentage of Total # of Waters	Acidification Status
less than 5.00	212	25.0	critical
5.00-6.00	256	30.1	endangered
above 6.00	381	44.9	satisfactory
	849		

Table III. Approximate pH at which fish in the LaCloche Mountain Lakes (Ontario, Canada) stopped reproduction - Modified from Beamish 1976

pH Range	Species
6.0+ to 5.5	Smallmouth bass Walleye
5.5 to 5.2	Lake trout
5.2 to 4.7	Brown bullhead White sucker Rock bass
4.7 to 4.5	Lake herring Yellow perch Lake chub

FIGURE 1 Boundary of Adirondack Ecological Zone

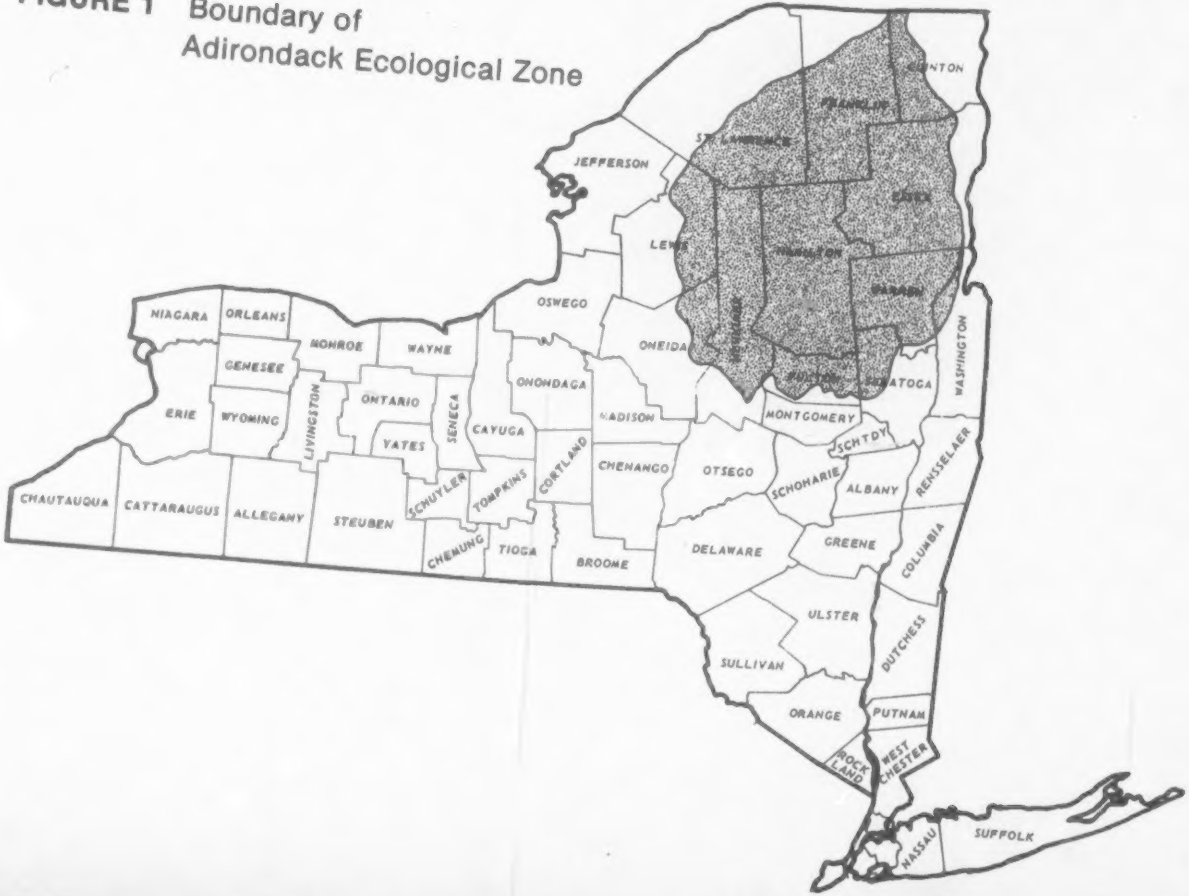

CLINTON
FRANKLIN
ST. LAWRENCE
ESSEX
JEFFERSON
LEWIS
HAMILTON
WARREN
HERKIMER
FULTON
SARATOGA
WASHINGTON
OSWEGO
ONEIDA
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
ONTARIO
ONONDAGA
MADISON
MONTGOMERY
ERIE
WYOMING
LIVINGSTON
YATES
SENECA
CAYUGA
SCHTDY
RENSSELAER
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
SCHUYLER
TOMPKINS
CORTLAND
CHENANGO
OTSEGO
SCHOHARIE
ALBANY
CHEMUNG
TIOGA
BROOME
DELAWARE
GREENE
COLUMBIA
ULSTER
SULLIVAN
DUTCHESS
ORANGE
PUTNAM
ROCK LAND
WEST CHESTER
NASSAU
SUFFOLK

FIGURE 2
Map of Adirondack Region
with 15'USGSquadrangles

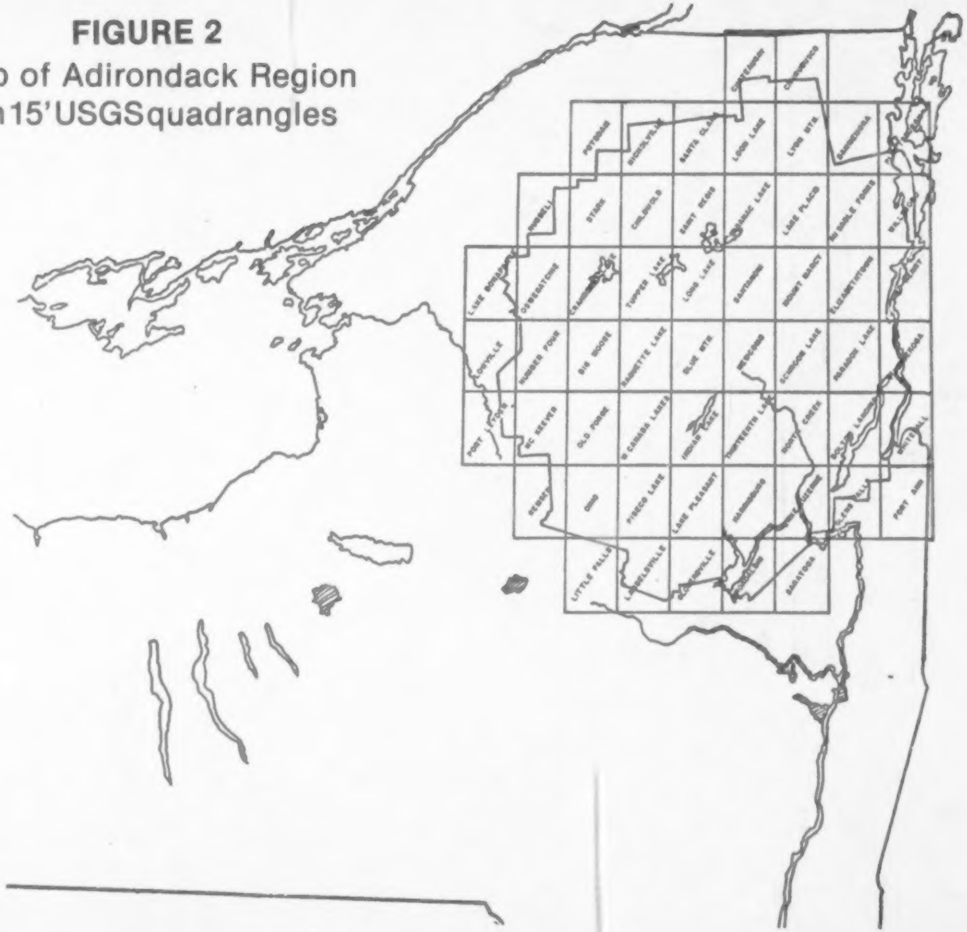

CHATEAUGAY
CHURUBUSCO
POTSDAM
NICHOLVILLE
SANTA CLARA
LOON LAKE
LYON MTN
DANNEMORA
RUSSELL
STARK
CHILDWOLD
SAINT REGIS
SARANAC LAKE
LAKE PLACID
AU SABLE FORKS
WILLSBORO
LAKE BONAPARTE
OSWEGATCHIE
CRANBERRY LAKE
TUPPER LAKE
LONG LAKE
SANTANONI
MOUNT MARCY
ELIZABETHTOWN
PORT HENRY
LOWVILLE
NUMBER FOUR
BIG MOOSE
RAQUETTE LAKE
BLUE MTN
NEWCOMB
SCHROON LAKE
PARADOX LAKE
TICONDEROGA
PORT LEYDEN
MC KEEVER
OLD FORGE
W CANADA LAKES
INDIAN LAKE
THIRTEENTH LAKE
NORTH CREEK
BOLTON LANDING
WHITEHALL
REMSEN
OHIO
PISECO LAKE
LAKE PLEASANT
HARRISBURG
LAKE LUZERNE
GLENS FALLS
FORT ANN
LITTLE FALLS
LASSELLSVILLE
GLOVERSVILLE
SARATOGA

FIGURE 3
ADIRONDACK MOUNTAIN REGION

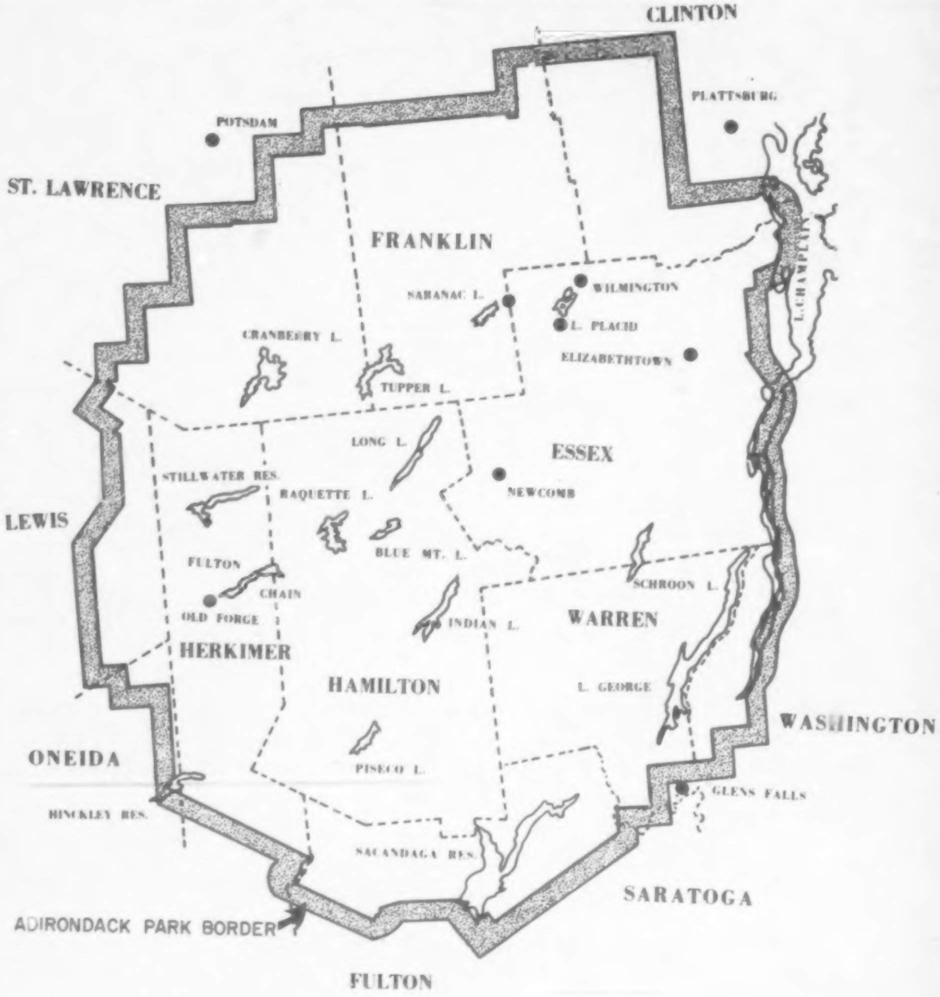
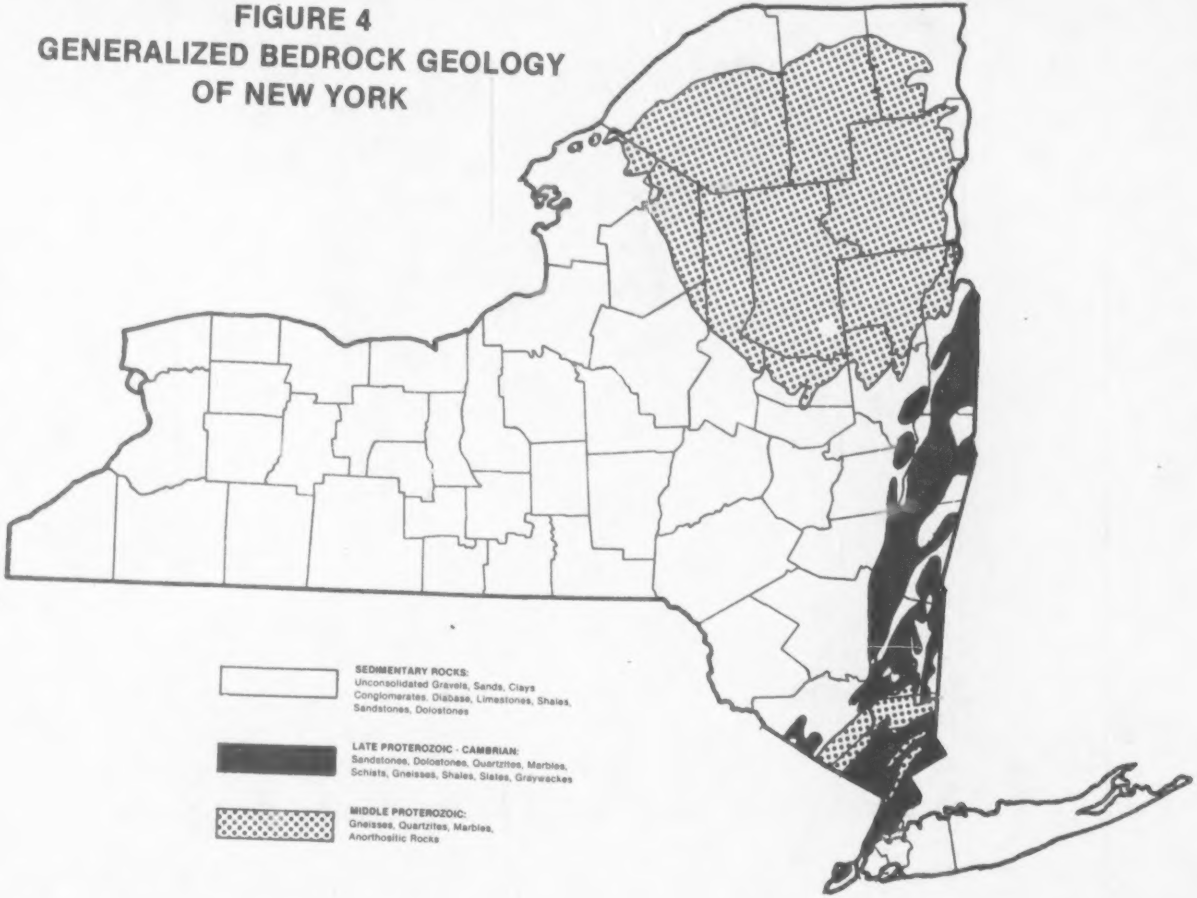

CLINTON
PLATTSBURG
POTSDAM
ST. LAWRENCE
FRANKLIN
L. CHAMPLAIN
SARANAC L.
WILMINGTON
L. PLACID
CRANBERRY L.
ELIZABETHTOWN
TUPPER L.
LONG L.
ESSEX
STILLWATER RES.
RAQUETTE L.
NEWCOMB
LEWIS
BLUE MT. L.
FULTON
CHAIN
SCHROON L.
OLD FORGE
INDIAN L.
WARREN
HERKIMER
HAMILTON
L. GEORGE
WASHINGTON
ONEIDA
PISECO L.
GLENS FALLS
HINCKLEY RES.
SACANDAGA RES.
SARATOGA
ADIRONDACK PARK BORDER
FULTON

FIGURE 4
GENERALIZED BEDROCK GEOLOGY
OF NEW YORK


SEDIMENTARY ROCKS:
Unconsolidated Gravels, Sands, Clays
Conglomerates, Diabase, Limestones, Shales,
Sandstones, Dolostones
LATE PROTEROZOIC - CAMBRIAN:
Sandstones, Dolostones, Quartzites, Marbles,
Schists, Gneisses, Shales, Slates, Graywackes
MIDDLE PROTEROZOIC:
Gneisses, Quartzites, Marbles,
Anorthositic Rocks

FOR WATERS SAMPLED SINCE 1974

FIGURE 5

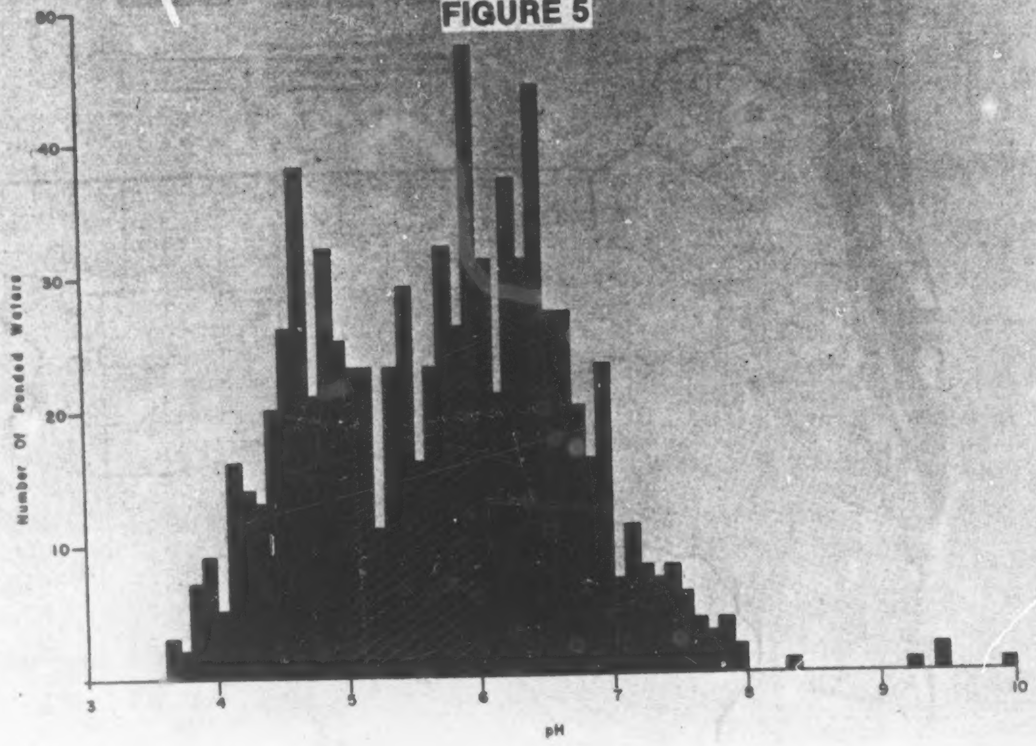
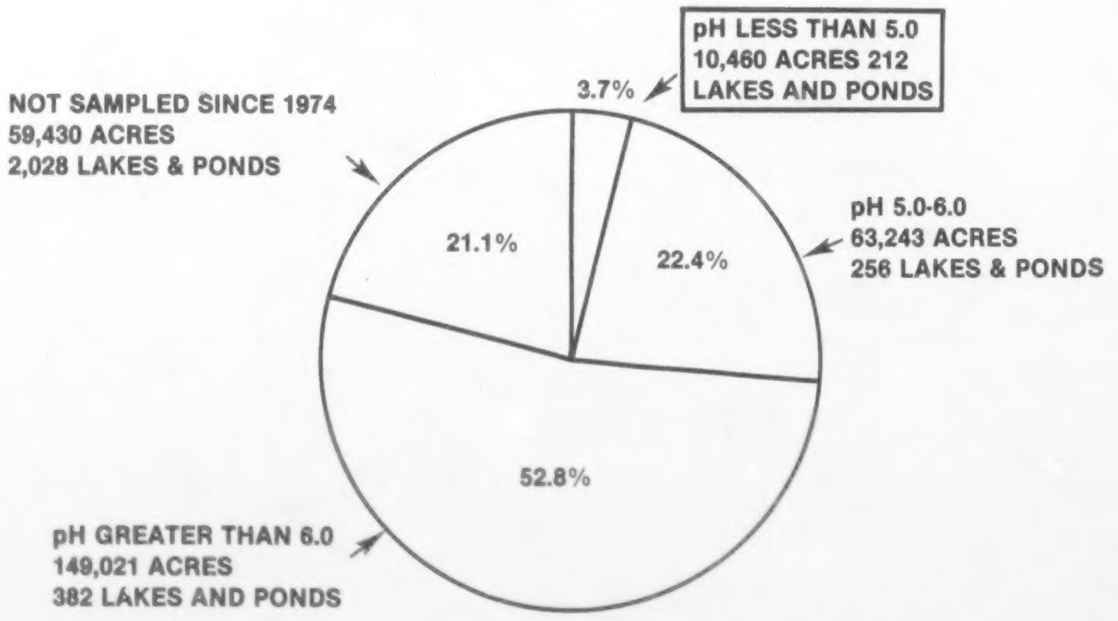


FIGURE 6 ACIDITY STATUS OF ADIRONDACK PONDED WATERS



TOTAL ACREAGE: 282,154

TOTAL # LAKES & PONDS: 2,877

OCCURRENCE BY SIZE
OF WATERS HAVING SUMMER pH OF LESS THAN 5.0

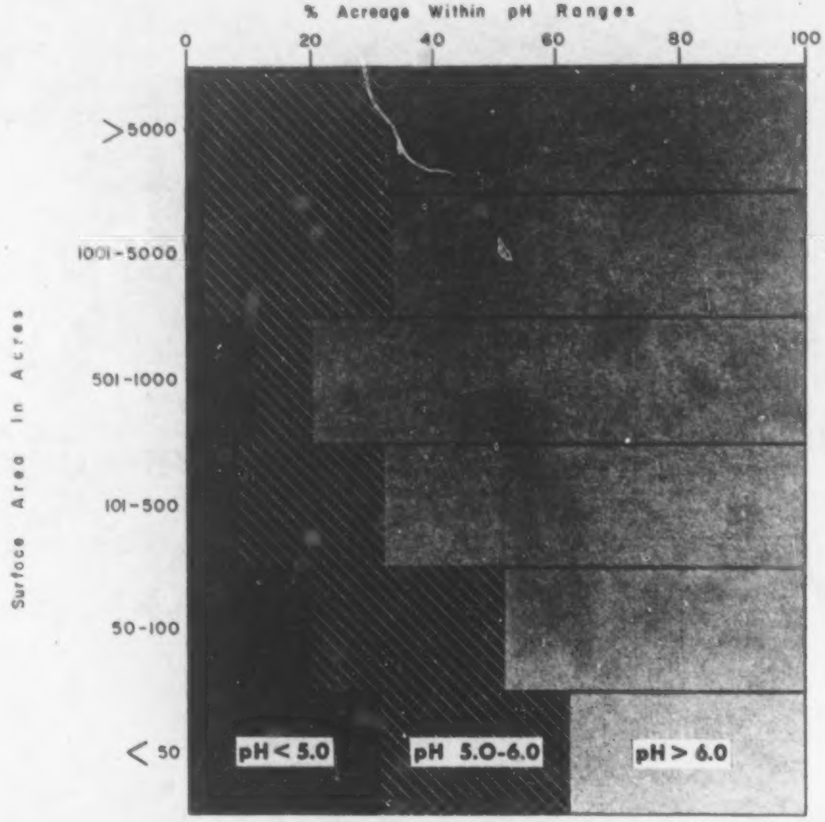


FIGURE 7

OCCURRENCE BY ELEVATION OF *ADIRONDACK* WATERS
IN VARIOUS pH CATEGORIES

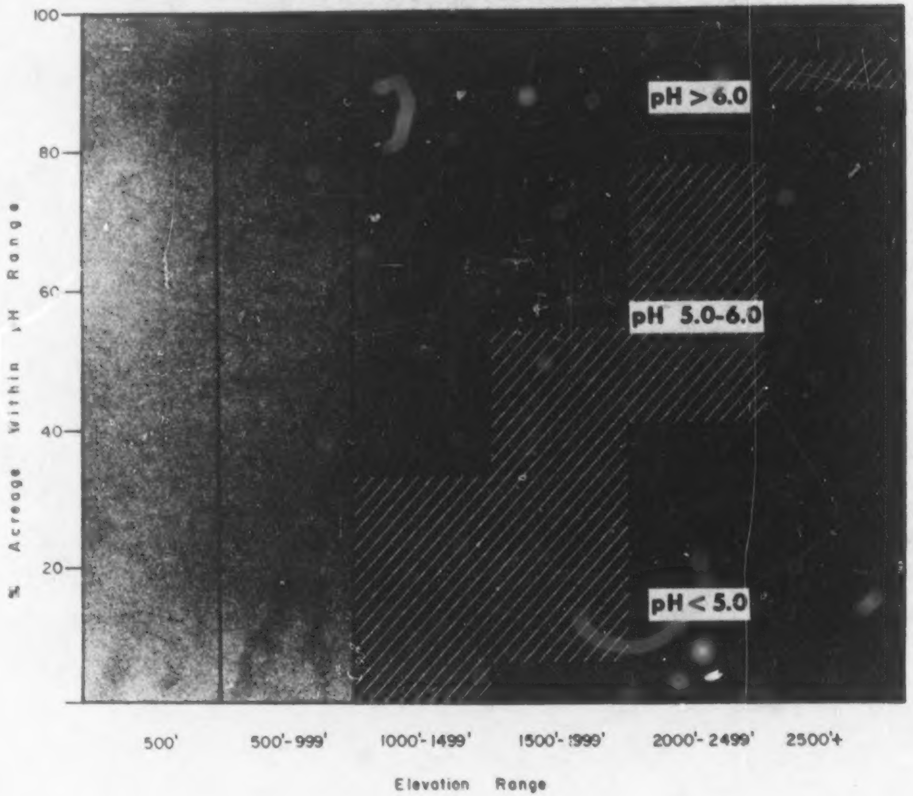
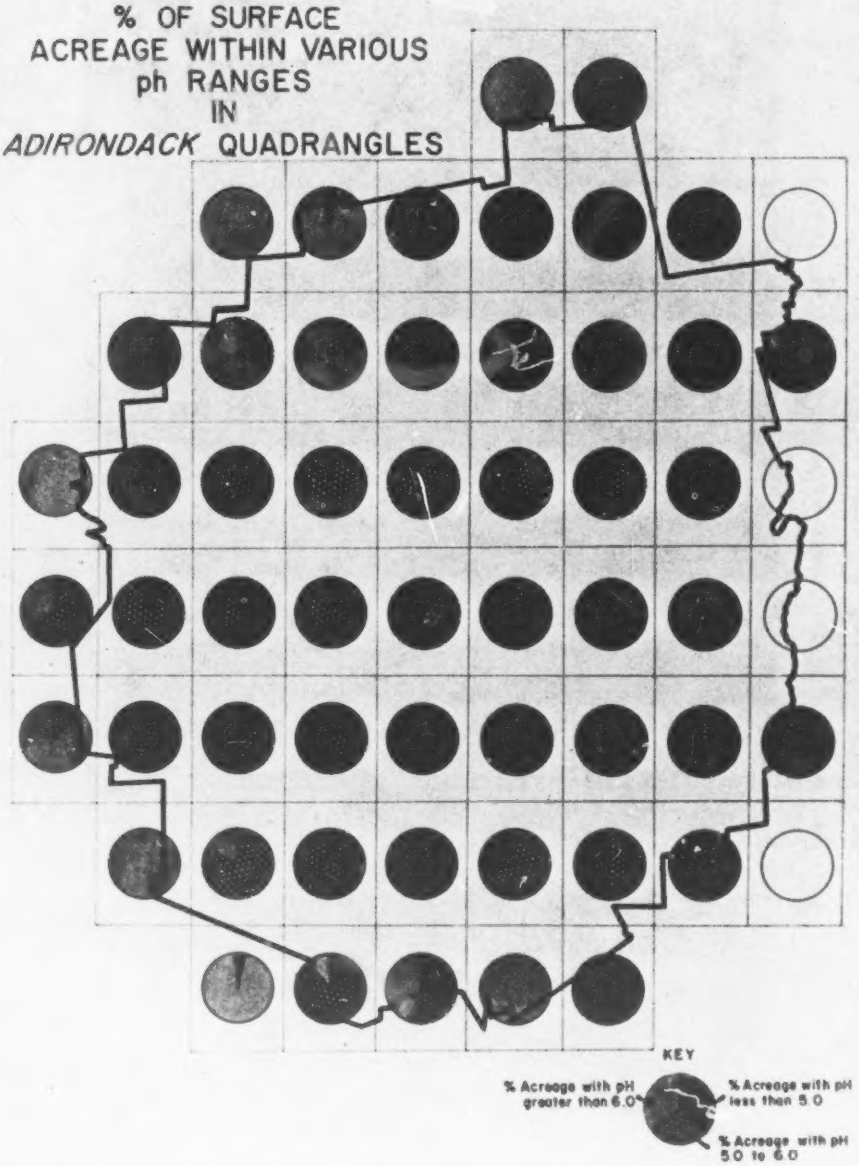
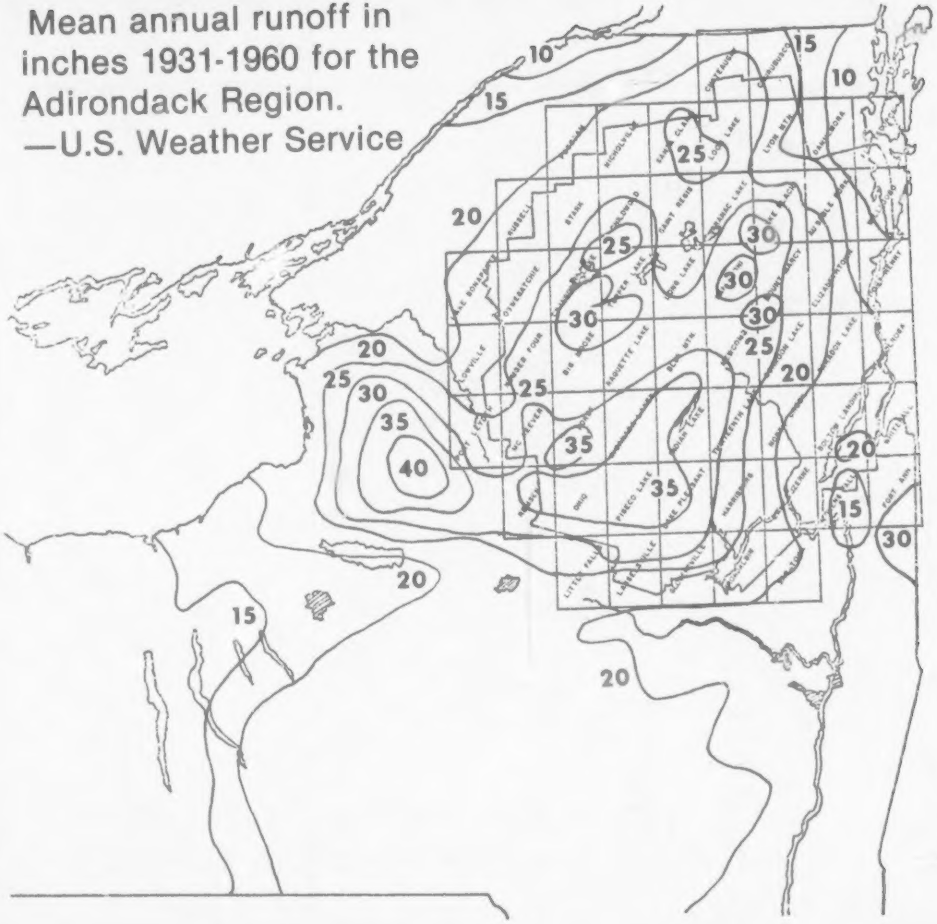


FIGURE 8

FIGURE 9

% OF SURFACE
ACREAGE WITHIN VARIOUS
ph RANGES
IN
ADIRONDACK QUADRANGLES


KEY
% Acreage with pH greater than 6.0
% Acreage with pH less than 5.0
% Acreage with pH 5.0 to 6.0


10
15
10
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10
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35
40
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35
20
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20
15
30
20

FIGURE 10 Mean annual runoff in inches 1931-1960 for the Adirondack Region.
—U.S. Weather Service

FIGURE 11 RELATIONSHIP BETWEEN pH–ALKALINITY
FOR 100 ADIRONDACK WATERS

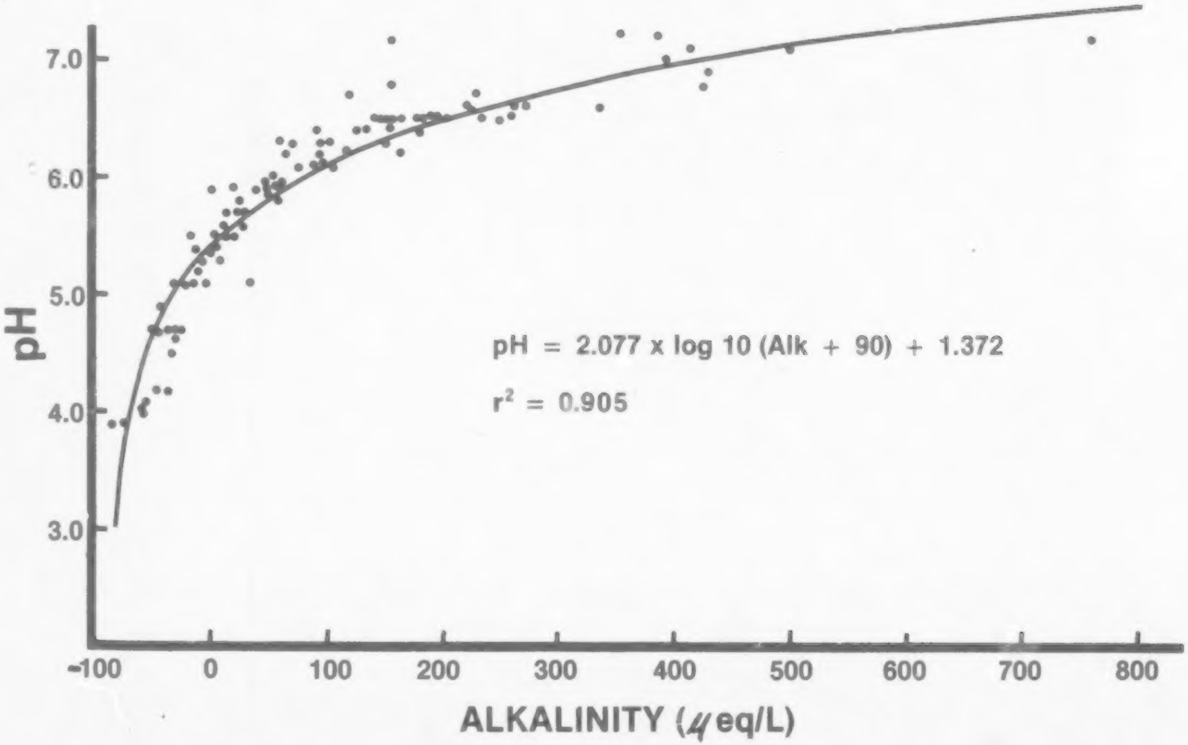


FIGURE 12
DISTRIBUTION
OF SUMMER ALKALINITY MEASUREMENTS
FOR WATERS SAMPLED SINCE 1974

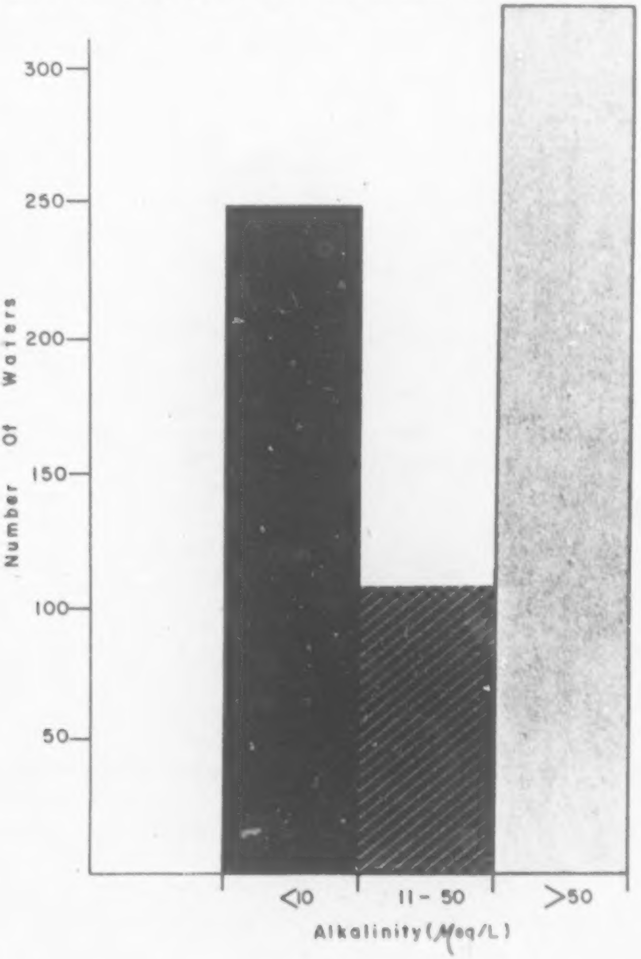


FIGURE 13 RELATIONSHIP BETWEEN TOTAL CALCIUM AND ALKALINITY FOR ADIRONDACK WATERS

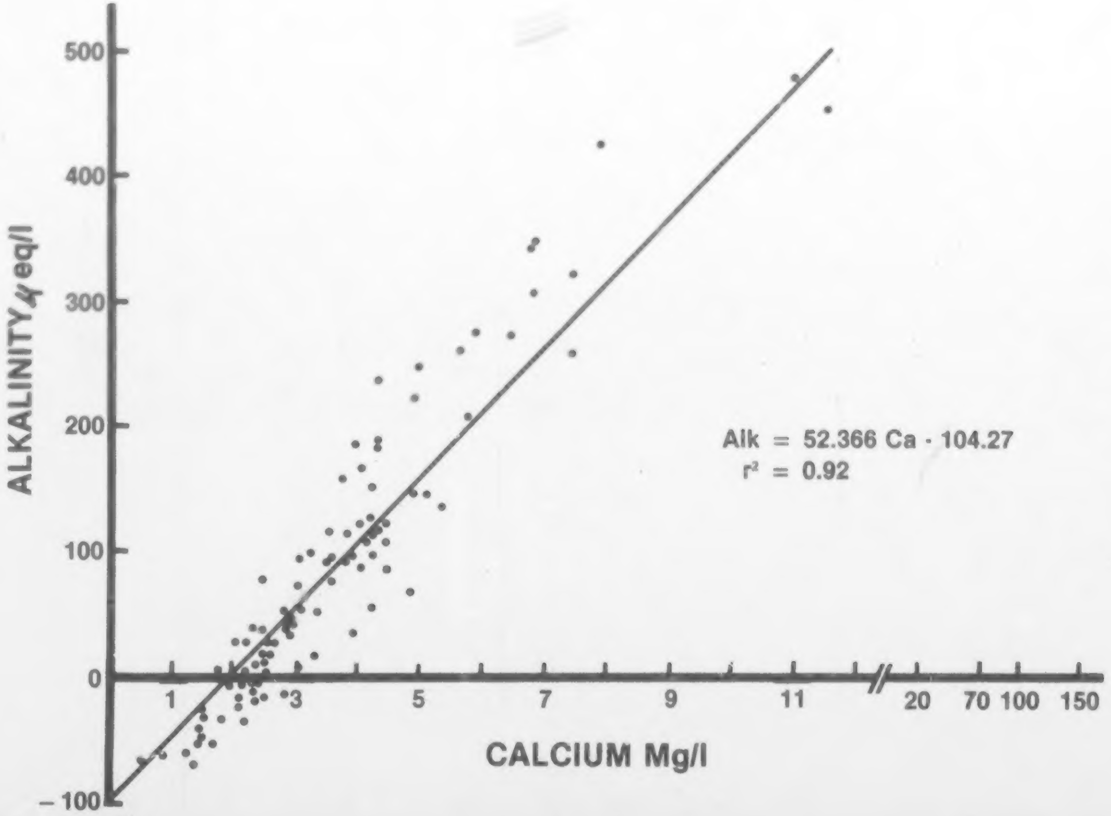


FIGURE 14 RELATIONSHIP BETWEEN pH AND TOTAL CALCIUM CONCENTRATIONS FOR ADIRONDACK WATERS

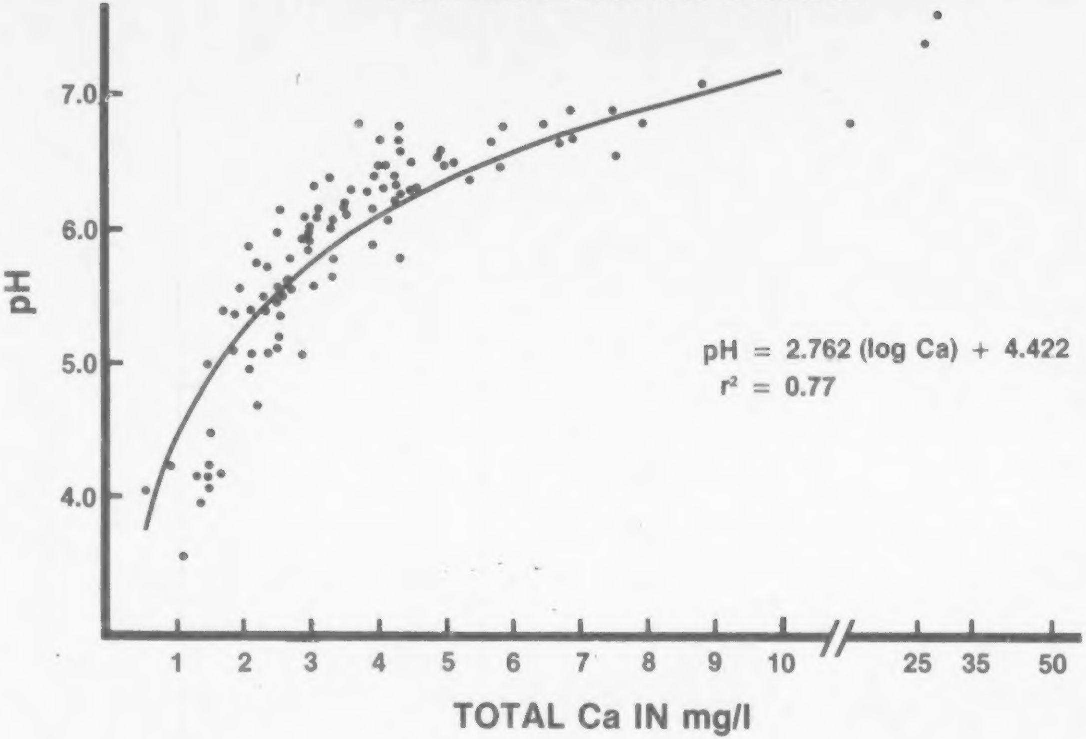


FIGURE 15 RELATIONSHIP BETWEEN pH AND CONDUCTIVITY FOR 100 ADIRONDACK WATERS

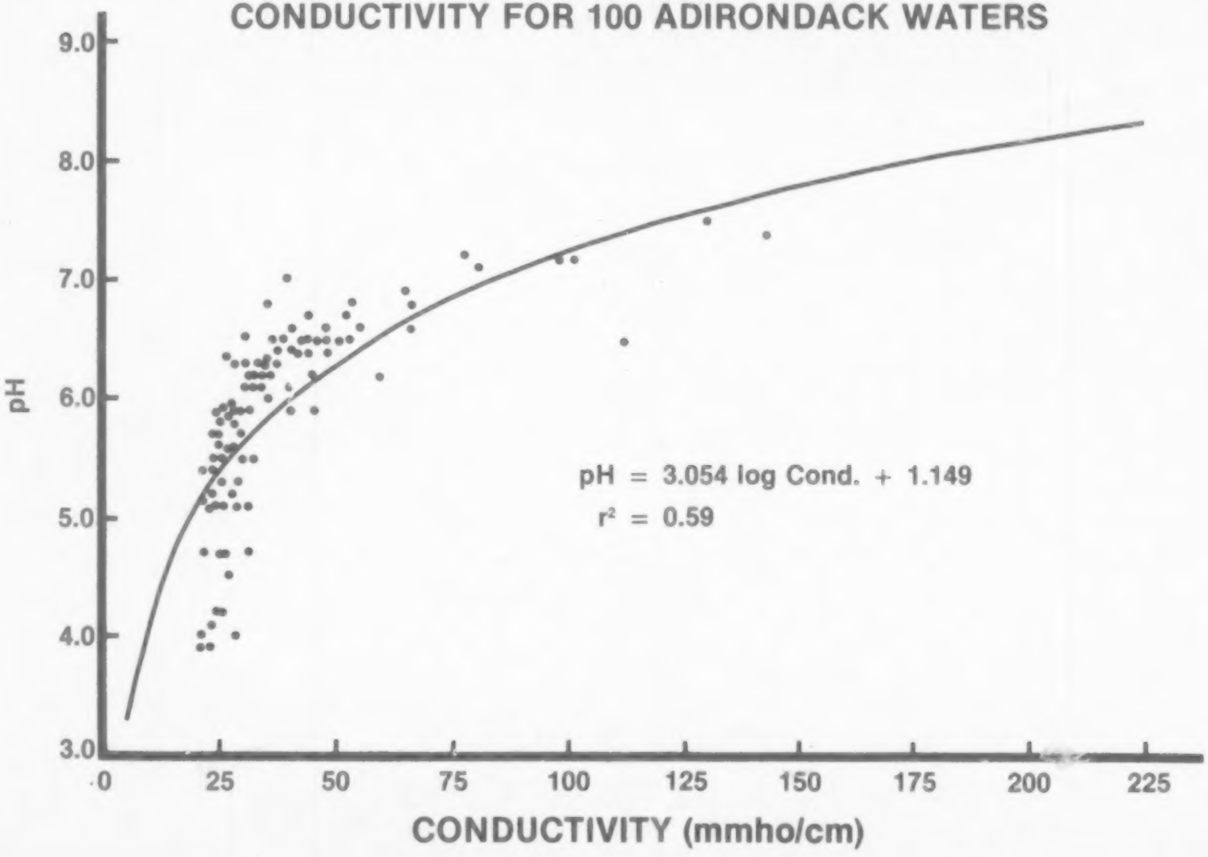


FIGURE 16
COMPARISON OF
METER pH AND COLORIMETRIC (HELLIGE) pH READINGS
FOR 100 ADIRONDACK LAKE SAMPLES

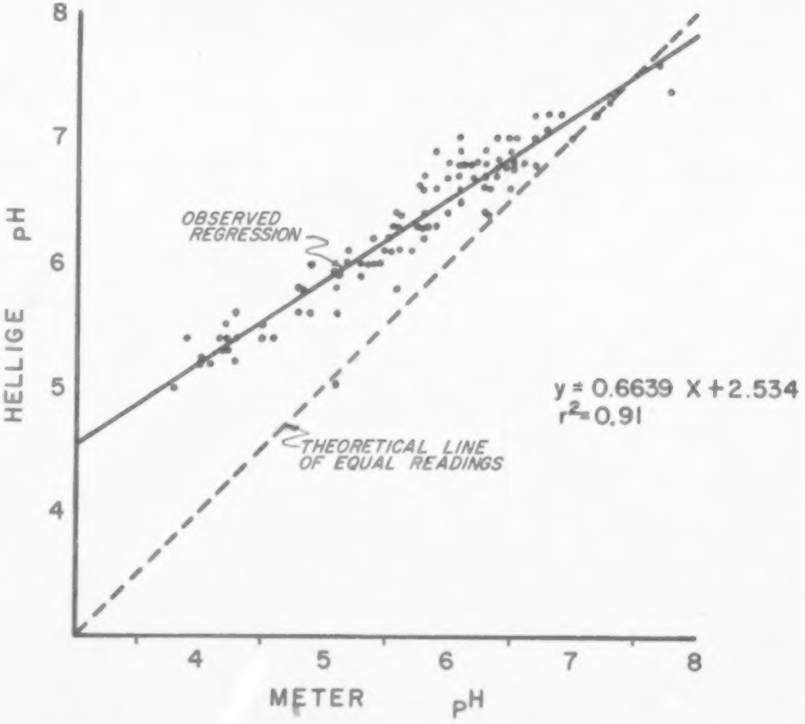
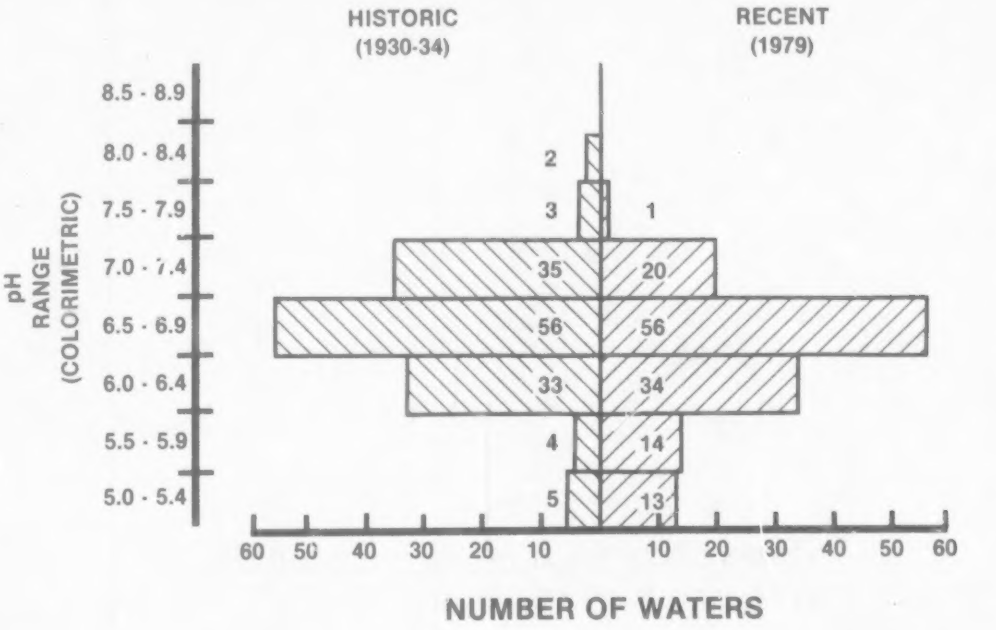


FIGURE 17 CHANGE IN COLORIMETRIC DETERMINED pH DISTRIBUTION OF 138 ADIRONDACK LAKES



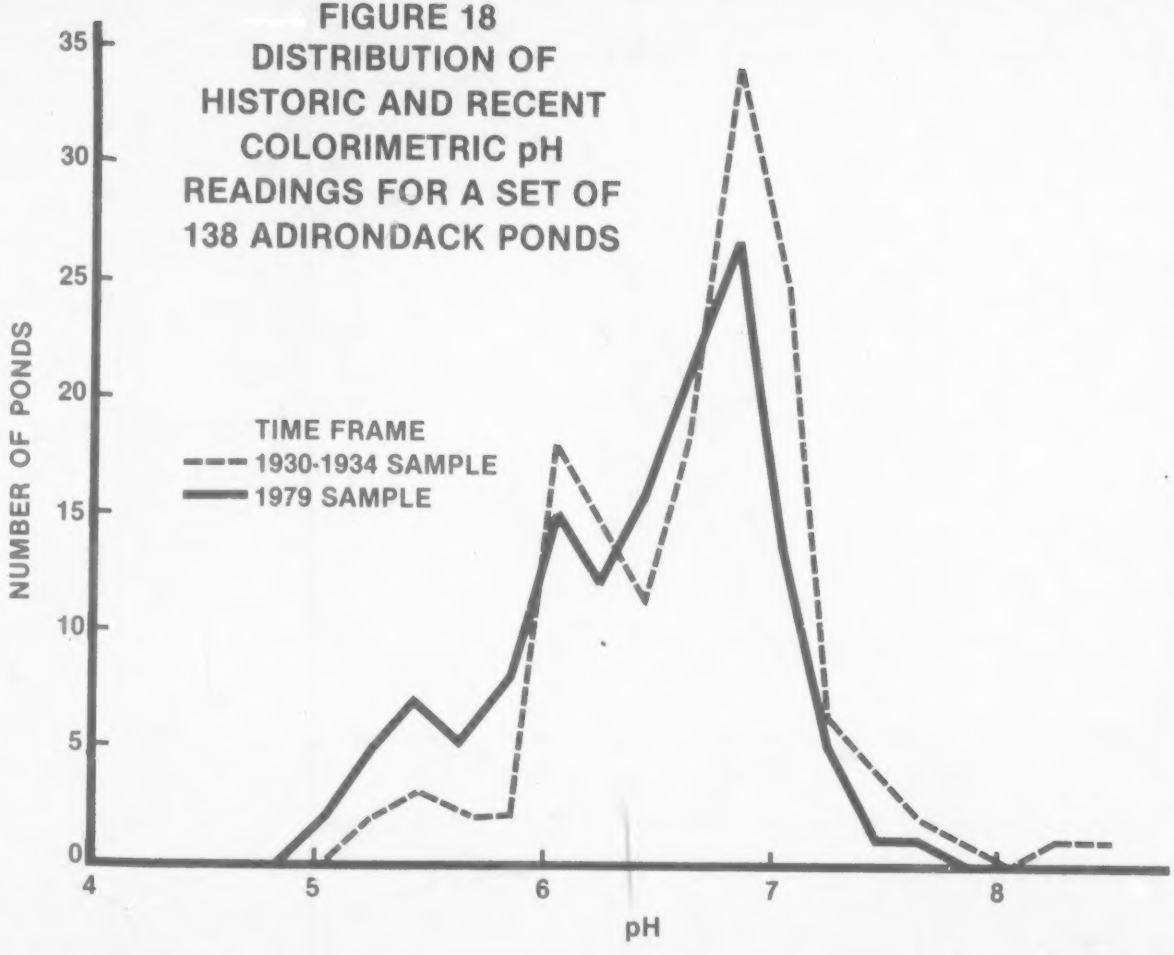


FIGURE 18
DISTRIBUTION OF
HISTORIC AND RECENT
COLORIMETRIC pH
READINGS FOR A SET OF
138 ADIRONDACK PONDS

FIGURE 19 CUMULATIVE COMPARISON OF HISTORIC AND RECENT pH VALUES FOR A SET OF 138 ADIRONDACK LAKES

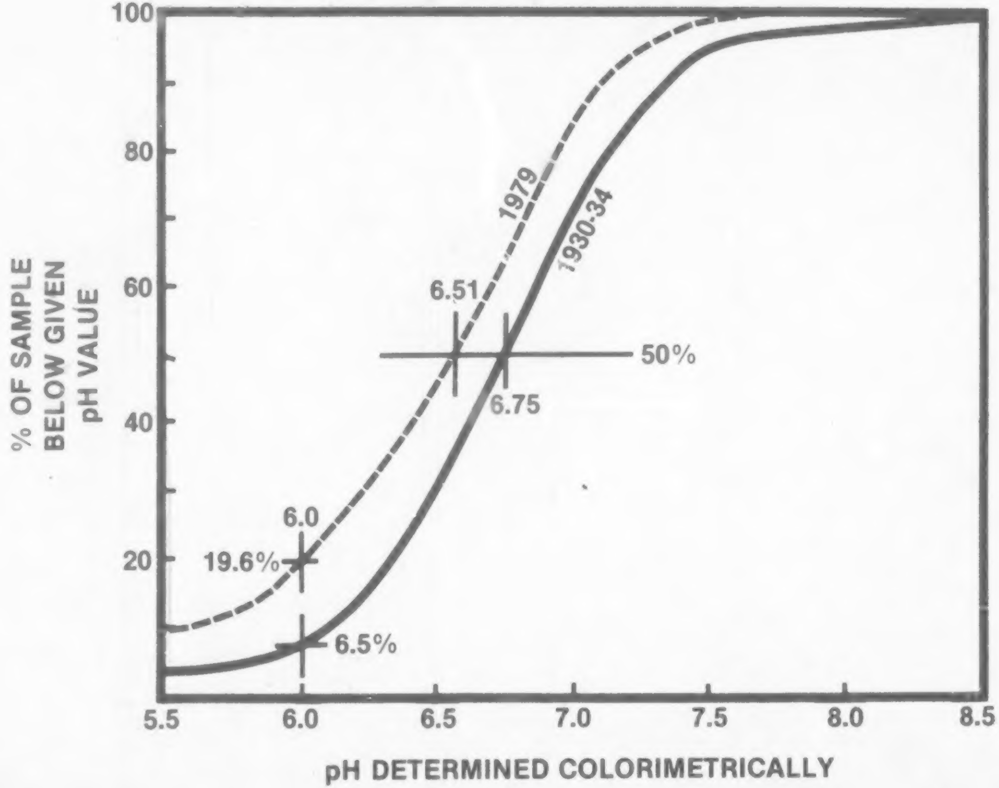
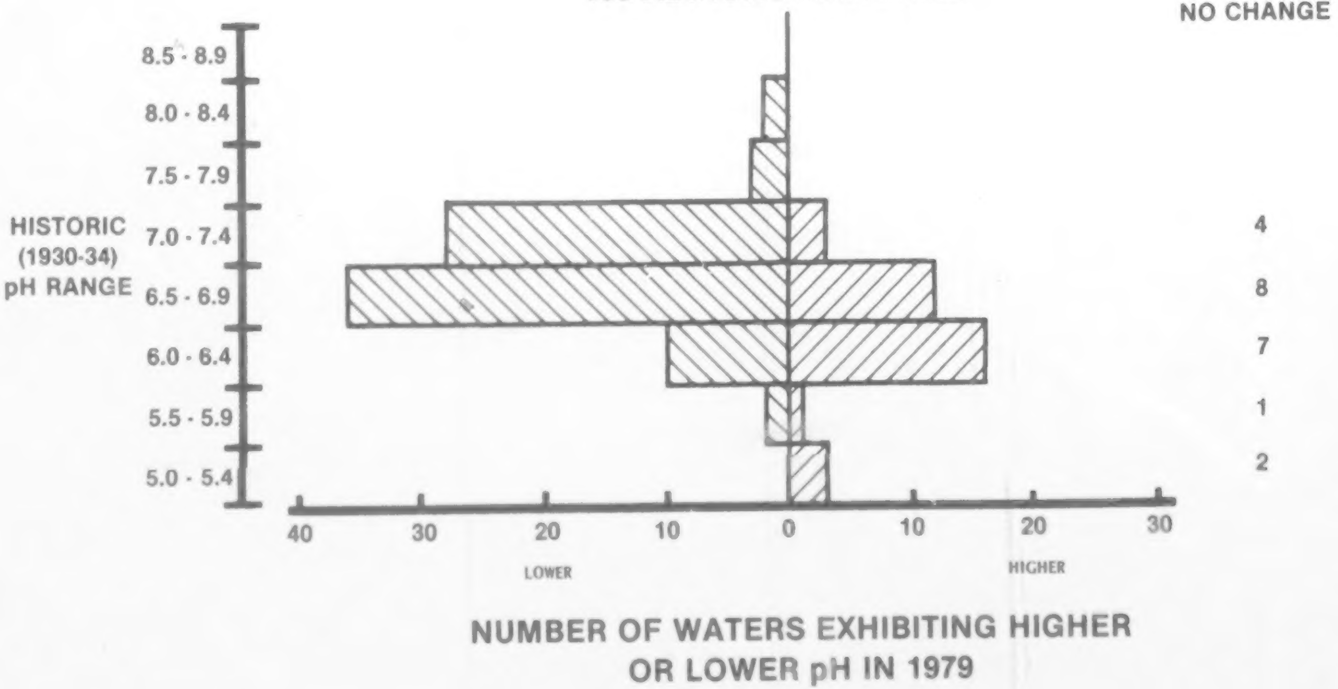


FIGURE 20 COMPARISON OF HISTORIC AND RECENT pH VALUES (COLORIMETRIC) FOR A SET OF 138 ADIRONDACK LAKES



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Appendix I

Adirondack Lake and Pond Survey
Key Chemistry Information

July 1980

Appendix to NYSDEC Report "Acidity Status of Lakes in the Adirondack Region of New York in Relation to Fish Resources" by Martin H. Pfeiffer and Patrick J. Festa - July 1980

Explanation of Codes

W'SHED P#: The watershed number refers to the major basin in which the lake or pond lies and follows the watershed boundaries described in the 1930-1934 Biological Surveys. The P# is the identification number assigned to individual ponded waters within each watershed. Example: 5-587A Adirondack Lake - 5 is the code for the Upper Hudson Watershed, 587A is the pond number assigned to Adirondack Lake. Following are the watershed codes used in Appendix I.

Code	Watershed	Code	Watershed
01	Oswego	05	Upper Hudson
02	Lake Champlain	06	Raquette
03	St. Lawrence	07	Mohawk Hudson
04	Oswegatchie/Black	08	Ontario
		09	Delaware/Susquehanna

7.5' QUAD: Refers to the 7 1/2 minute Latitude x Longitude U. S. Geological Survey Quadrangle in which the outlet of the lake lies. Many areas of the Adirondacks have only been mapped on 15 minute quadrangles; in these cases, the last digit refers to 7 1/2' quadrant on the 15 minute map in which the lake or pond outlet lies. Example: F233 refers to the South-West quadrant of the Blue Mountain 15' USGS Quadrangle. The code and relative location of the 15' quadrangles are displayed on the accompanying diagram.

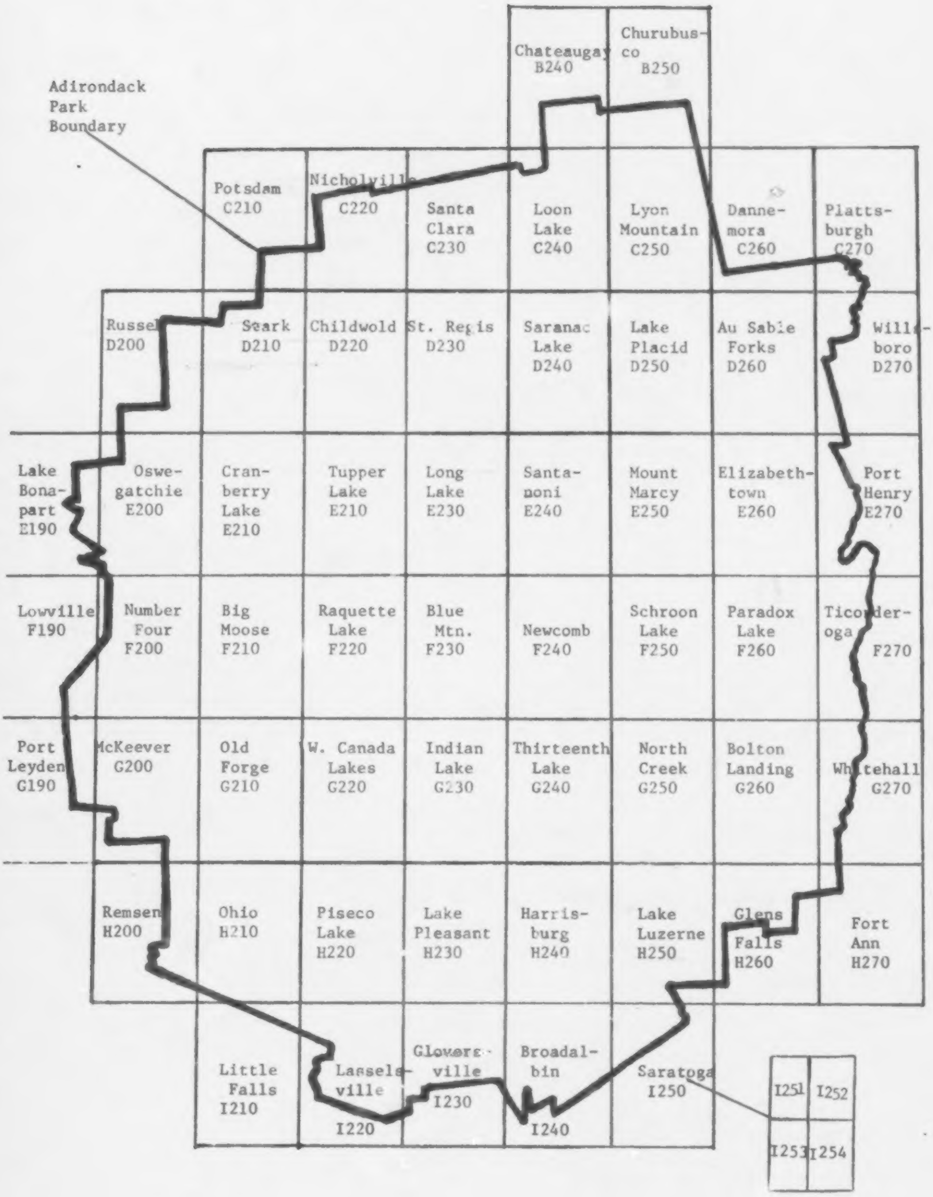
SURF AREA: Area of the lake surface to nearest acre. Taken from "Characteristics of New York Lakes, Part I Gazetteer of Lakes, Ponds and Reservoirs, Bulletin 68, 1970, by U. S. Geological Survey and NYSDEC,,or from U.S.G.S. Topographical Maps.

SURF ELEV: Elevation, in feet above mean sea level, of the lake surface. Elevation was taken from "Part I Gazetteer of Lakes, Ponds and Reservoirs, U.S.G.S. Topographical Maps or NYSDEC survey maps.

CNTY. Refers to the county in which the lake or pond outlet lies.

County Codes

Code	County	Code	County
10	Clinton	29	Montgomery
16	Essex	33	Oneida
17	Franklin	38	Oswego
18	Fulton	45	St. Lawrence
21	Hamilton	46	Saratoga
22	Herkimer	47	Schenectady
23	Jefferson	57	Warren
25	Lewis	58	Washington


Chateaugay B240
Churubusco B250
Adirondack Park Boundary
Potsdam C210
Nicholville C220
Santa Clara C230
Loon Lake C240
Lyon Mountain C250
Dannemora C260
Plattsburgh C270
Russell D200
Stark D210
Childwold D220
St. Regis D230
Saranac Lake D240
Lake Placid D250
Au Sable Forks D260
Willsboro D270
Lake Bonaparte E190
Oswegatchie E200
Cranberry Lake E210
Tupper Lake E210
Long Lake E230
Santanoni E240
Mount Marcy E250
Elizabethtown E260
Port Henry E270
Lowville F190
Number Four F200
Big Moose F210
Raquette Lake F220
Blue Mtn. F230
Newcomb F240
Schroon Lake F250
Paradox Lake F260
Ticonderoga F270
Port Leyden G190
McKeever G200
Old Forge G210
W. Canada Lakes G220
Indian Lake G230
Thirteenth Lake G240
North Creek G250
Bolton Landing G260
Whitehall G270
Remsen H200
Ohio H210
Piseco Lake H220
Lake Pleasant H230
Harrisburg H240
Lake Luzerne H250
Glens Falls H260
Fort Ann H270
Little Falls I210
Lassellsville I220
Gloversville I230
Broadalbin I240
Saratoga I250
I251
I252
I253
I254

ADK ZONE: Refers to the NYSDEC Fisheries classification for the subject water

Code	
1	Brook Trout Ponds
2	Two-Story Lakes and Ponds - contains both coldwater and warmwater sport fish
3	Cold Water Ponds - contains trout and/or salmon other than brook trout and not managed primarily for brook trout
4	Warm Water Lakes and Ponds - contains warmwater sport fish species; i.e., bass, walleye, pike.
5	Acidified Lakes and Ponds - high acidity prohibits maintenance of viable sport fish population
6	Fisheries Classification Undetermined
7	Limed - Maintenance of sport fish population dependent upon treatment with lime.

DATE PH: The date on which the water sample was collected

SURF PH: pH of sample collected at or within 1 meter of lake surface. All 1979 dated samples were collected at 1 meter depth.

PH MTH: The analysis method employed for determining sample pH. Eq.M = Equilibrium Meter. Determination made under air CO_2 equilibrium conditions with laboratory grade electronic pH meter by procedures described in Appendix II. METER = determination made with electronic pH meter, not necessarily under air CO_2 equilibrium conditions. Readings on 1975 dated samples were taken after the sample was vigorously shaken. UNKN = Method of pH determination unknown. Most of these readings were obtained in the field with portable, battery operated pH meters.

ALKAL UEQ/L: Total alkalinity reported as micro-equivalents per liter (ueq/l). 1979 and 1975 dated samples were analyzed via procedures in Appendix II.

SURF COND: Surface conductivity reported in μmhos/cm. Obtained via electronic conductivity meter.

CA MG/L: Total calcium concentration reported in mg/l. Analysis via Atomic Absorption Spectrophotometric Analysis.

DATA SOURCE: 1 - Samples collected and analyzed by NYSDEC staff
2 - Samples collected and analyzed by Dr. Carl Schofield, Cornell University, under research contract administered by NYSDEC and partially funded by U. S. Fish and Wildlife Service, Dingell-Johnson Federal Aid to Fisheries Funds
3 - Data contributed by Don Charles of Indiana University, collected as part of M.S. thesis work.

ADIRONDACK LAKE AND POND SURVEY

KEY CHEMISTRY INFORMATION

JUNE 10, 1980

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
5- 587A	ADIRONDACK LAKE	F233	00219	1660	21	4	06/27/79	6.89	EQ.M	476	79.50	11.02	1
7- 891	ALE POND	H221	13	2410	21	5	06/24/75	4.55	METER	-19	030.75	1.78	2
2- 96	ALFORD POND	D243	00032	1954	16	5	06/21/79	4.20	EQ.M	-65	15.20	1.26	1
6- 315	ALUMINUM POND	F223	6	2425	21	5	06/24/75	4.59	METER	-19	34.47	1.94	2
7- 907	AMOS LAKE	G223	13	2310	21	1	06/24/75	5.88	METER	011	026.10	2.40	2
6- 11	ARBUCKLE POND	C214	45	883	45	4	08/21/79	6.38	EQ.M	128	40.00	4.21	1
5- 684	ARBUTUS LAKE	F241	115	1693	16	1	07/24/78	6.86	METER	59	26.50	-	3
3- 103A	ARQUETT POND	C223	19	1470	45	6	08/21/79	5.95	EQ.M	46	29.30	2.88	1
4- 326	ASH POND	F213	00004	1615	45	3	09/08/75	6.00	UNKN		.	-	1
2- 213	AUGUR LAKE	D271	00378	0550	16	4	08/20/79	7.22	EQ.M	353	77.90	8.16	1
5- 516	AUSTIN POND	G251	00019	1180	57	4	08/30/79	7.24	EQ.M	476	89.70	12.31	1
5- 707	AVALANCHE LAKE	E251	13	2863	16	5	07/20/78	4.89	METER	-6	21.70	2.08	2
7- 876	BABY LAKE	H212	00032	2182	22	5	06/24/75	4.85	METER	-12	027.37	3.64	2
5- 397	BAILEY POND	F254	00019	1656	16	1	07/19/78	6.50	METER		022.00	-	1
5- 555	BALFOUR POND	E243	00083	1786	16	3	08/29/79	6.26	EQ.M	67	86.60	4.42	1
7-109C	BALLSTON LAKE	J252	00017	0251	46	4	09/09/78	7.20	UNKN	085	250.00	-	1
4- 837	BALSAM LAKE	G212	00019	1946	22	5	08/27/79	4.98	EQ.M	-25	21.60	1.54	1
7- 909	BALSAM LAKE	G223	00038	2411	21	5	06/24/75	4.86	METER	-09	028.80	1.50	2
5- 636	BARKER POND	F233	00013	1845	21	1	07/24/79	5.17	EQ.M	-10	23.60	2.03	1
2- 35	BARNES POND	C252	00013	1470	10	4	08/20/79	7.05	EQ.M	575	91.50	8.80	1
5- 366	BARNES POND	F254	00013	1945	16	1	07/14/77	5.50	UNKN		.	-	1
3- 262	BARNUM POND	D232	00083	1653	17	1	08/21/79	6.31	EQ.M	146	56.40	4.58	1
2- 338	BARTLETT POND	E263	00070	1230	16	4	08/22/79	6.49	EQ.M	251	46.60	5.25	1
7- 787	BARTO LAKE	H224	00019	2260	21	5	06/24/75	4.73	METER	-7	027.36	1.20	2
2- 51	BASS LAKE	C243	6	1710	17	5	06/19/78	4.69	METER	-17	16.60	-	3
5- 464	BASS LAKE	F261	00038	1231	16	1	08/30/79	5.76	EQ.M	52	36.50	4.34	1
4- 330	BASSOUT POND	E213	19	1754	45	5	07/27/76	6.80	UNKN	120	.	-	1
4- 968	BEAR LAKE	G203	00045	1610	22	1	08/27/79	6.12	EQ.M	36	27.70	2.48	1
2- 353	BEAR POND	F263	00013	1410	16	4	08/01/79	6.24	EQ.M	147	37.60	4.46	1
3- 271	BEAR POND	D232	58	1638	17	1	07/12/78	5.08	METER	-13	22.80	-	3
4- 196	BEAR POND	F202	64	2044	22	5	06/24/75	4.47	METER	-27	34.46	1.10	2
4- 880	BEAR POND	G221	26	2087	21	5	06/24/75	4.77	METER	-8	28.45	2.00	2
6- 303	BEAR POND	F223	6	2050	21	1	06/24/75	6.15	METER	45	29.87	2.76	2
7- 881	BEAR POND	H221	6	2295	21	5	06/24/75	4.97	METER	-01	025.04	1.88	2
5- 699A	BEAVER FLOW	F242	115	1726	16	1	08/29/79	6.38	EQ.M	116	33.20	3.92	1
4- 449	BEAVER LAKE	F204	00282	1426	25	4	08/23/79	5.07	EQ.M	-17	26.40	2.39	1
4- 849	BEAVER LAKE	G221	00122	1836	21	3	08/28/79	5.62	EQ.M	9	27.20	2.37	1
5- 671	BEAVER POND	G224	96	2442	21	4	06/24/75	5.24	METER	004	192.22	1.64	2
7- 915	BEAVER POND	G224	6	2210	21	4	06/24/75	6.13	METER	055	023.14	2,40	2
3- 201	BEAVER VALLEY POND	D232	00013	1650	17	1	08/09/76	6.00	UNKN		.	-	1
5- 182	BENNETT LAKE	H244	00032	1162	21	1	08/29/79	5.39	EQ.M	-6	22.80	2.17	1
2- 356	BERRYMILL POND	F263	00032	1675	16	4	08/30/79	6.21	EQ.M	90	32.10	3.75	1
3- 146	BESSIE POND	D231	00019	1627	17	1	08/01/77	6.50	UNKN		.	-	1
7- 790	BIG ALDERBED	H224	00070	1835	21	5	08/28/79	4.13	EQ.M	-56	23.90	1.64	1
2- 241	BIG CHERRYPATCH POND	D254	00013	1655	16	1	08/20/79	6.39	EQ.M	244	96.40	6.88	1
4- 360	BIG DEER POND	E213	00058	1749	21	4	08/23/79	5.40	EQ.M	-12	23.10	2.08	1
4- 733	BIG DIAMOND POND	F214	6	2010	22	5	06/24/75	4.88	METER	-9	22.01	1.38	2
2- 59	BIG HOPE POND	C244	00019	1712	17	3	08/20/79	5.06	EQ.M	-4	25.40	-	1
5- 454	BIG MARSH POND	F252	00026	1550	16	1	08/30/79	6.14	EQ.M	98	31.60	3.92	1
7- 821	BIG METCALF LAKE	H214	00013	2167	21	5	06/24/75	4.70	METER	-13	024.10	1.30	2

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
4- 752	BIG MOOSE LAKE	F213	01286	1825	22	5	06/23/79	4.17	EQ.M	-48	27.60	2.13	1
4- 676	BIG OTTER LAKE	G202	00267	1584	22	1	08/27/79	5.77	EQ.M	39	27.60	2.37	1
2- 98	BIG PINE POND	D244	45	1560	17	3	08/04/78	7.07	METER	68	27.00	-	3
2- 263	BIG POND	D263	00045	0618	16	3	08/20/79	6.98	EQ.M	514	79.50	10.70	1
7- 883	BIG ROCK LAKE	H221	77	2316	21	5	06/26/75	4.98	METER	-04	025.50	1.70	2
5- 406	BIG ROGERS POND	F253	00237	1281	16	4	08/30/79	6.49	EQ.M	143	43.40	5.17	1
5- 383	BIG SHERMAN POND	F254	00026	1570	16	1	07/19/78	5.70	UNKN		021.00	-	1
5- 395	BIGSBY POND	F254	00077	1556	16	2	08/30/79	5.83	EQ.M	21	70.90	2.62	1
7- 776	BILLS POND	H224	00006	2200	21	5	06/24/75	4.37	METER	-37	048.00	1.10	2
5- 495	BIRCH POND	F264	00006	1310	16	1	08/22/79	6.24	EQ.M	114	36.20	4.23	1
5- 523	BIRD POND	G251	00013	1095	57	3	08/30/79	7.15	EQ.M	394	64.00	8.44	1
7- 780	BLACK CAT LAKE	H223	00032	1784	21	4	08/28/79	5.32	EQ.M	-10	19.80	1.74	1
4- 996	BLACK CREEK LAKE	H211	00096	1905	22	1	08/27/79	5.31	EQ.M	-6	21.30	1.83	1
4- 1	BLACK LAKE	C194	08352	0272	45	4	08/11/78	9.50	COLOR	960	.	-	1
5- 547	BLACK MOUNTAIN POND	F243	00006	1990	21	1	08/29/79	5.66	EQ.M	17	29.80	2.81	1
2- 130	BLACK POND	D234	00019	1579	17	1	07/20/77	6.10	METER		.	-	1
3- 256	BLACK POND	D232	00077	1620	17	1	08/21/79	6.54	EQ.M	193	43.60	4.50	1
5- 128	BLACK POND	I251	00051	1670	46	4	08/30/79	5.78	EQ.M	25	28.50	2.68	1
4- 681	BLACKFOOT POND	G202	00013	1940	22	5	08/27/79	3.71	EQ.M	-108	22.50	0.84	1
7- 794	BLIND PANS VLY	H224	00013	1960	21	5	08/28/79	3.98	EQ.M	-68	22.40	1.18	1
6- 307	BLUE MOUNTAIN LAKE	F234	1261	1789	21	2	07/28/78	7.19	METER	88	37.40	-	3
6- 175	BOG LAKE	E213	00205	1742	21	1	08/23/79	6.09	EQ.M	39	26.90	2.90	1
3- 271A	BOG POND	D232	?	1650	17	6	07/12/78	5.51	METER	14	012.50	-	3
2- 193	BONE POND	D233	00013	1610	17	5	02/03/76	4.40	METER		.	-	1
3- 374	BOOTTREE POND	E221	00019	1520	45	7	06/28/78	5.90	METER		.	-	1
5- 564	BOREAS PONDS	E253	00109	1973	16	1	08/22/79	6.15	EQ.M	115	30.50	3.57	1
7- 775	BOWEN POND	H224	00009	2230	21	5	06/24/75	4.60	METER	-18	030.42	-	1
3- 329	BOYD POND	D202	00090	0874	45	2	08/21/79	6.13	EQ.M	111	39.20	4.12	1
7- 829	BOYER LAKE	H224	00026	1995	22	5	08/28/79	3.86	EQ.M	-86	23.50	1.18	1
3- 7	BRADLEY POND	E254	00109	1643	10	1	08/20/79	7.39	EQ.M	961	142.90	25.53	1
5- 717	BRADLEY POND	E243	6	2690	16	5	06/24/75	4.75	METER	-8	31.48	2.20	2
6- 277	BRANDRETH LAKE	F221	00896	1678	21	5	08/28/79	4.69	EQ.M	-34	26.90	2.20	1
4- 923	BRANDY LAKE	G204	00017	1540	33	1	03/11/75	5.20	UNKN	280	.	-	1
2- 115	BRANDY POND	D233	4	1600	17	4	07/14/78	5.20	METER	13	64.70	-	3
5- 347	BRANT LAKE	G261	01357	0797	57	4	08/10/77	7.50	UNKN		.	-	1
4- 689	BRANTINGHAM LAKE	G192	00346	1235	25	4	08/27/79	6.26	EQ.M	96	33.90	3.58	1
3- 268	BREAD POND	D232	00002	1655	17	1	02/24/76	5.80	METER		.	-	1
4- 967	BREWER LAKE	G203	00013	1870	22	7	01/28/75	5.30	UNKN		.	-	1
6- 178	BRIDGE BROOK POND	E212	00179	1595	45	1	06/22/79	6.20	EQ.M	86	32.70	3.34	1
4- 874	BROOK TROUT LAKE	G224	77	2369	21	5	06/24/75	4.99	METER	-4	24.96	1.88	2
5- 268	BROWN LAKE	I231	00017	1890	21	1	08/09/78	5.10	METER		018.00	-	1
6- 217	BRUEYER POND	E232	00013	1730	17	1	08/22/79	5.63	EQ.M	19	32.20	3.37	1
4- 748	BUGG LAKE	F213	00045	1815	22	1	08/23/79	5.63	EQ.M	13	27.60	2.33	1
2- 61	BUCK POND	C243	00109	1665	17	4	08/20/79	6.66	EQ.M	221	42.50	4.89	1
4- 246	BUCK POND	F202	00013	1795	22	1	08/23/79	5.32	EQ.M	0	27.00	2.46	1
4- 343	BUCK POND	E214	00013	1770	45	5	03/14/75	4.50	UNKN	136	.	-	1
4- 578	BUCK POND	F214	19	2016	22	7	06/14/76	5.10	UNKN	20	.	-	1
7- 666	BUCK POND	H222	6	2230	21	5	06/24/75	4.89	METER	-05	026.49	0.90	2
5- 285	BUCKHORN POND	G244	3	2490	21	1	06/24/75	5.59	METER	004	021.57	2.28	2
4- 789	BUG LAKE	F224	00083	1992	21	1	08/28/79	6.52	EQ.M	258	52.20	7.47	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
4- 30	BULLHEAD POND	E191	00051	0613	25	4	08/27/79	6.78	EQ.M	425	66.10	7.98	1
5- 320	BULLHEAD POND	H253	00006	1210	57	4	08/30/79	5.95	EQ.M	57	33.00	3.09	1
5- 582	BULLHEAD POND	F244	00019	1635	21	4	08/29/79	6.54	EQ.M	193	42.60	5.80	1
7- 927	BULLHEAD POND	G223	00006	2480	21	4	06/24/75	5.12		002	021.50	1.50	2
3- 375	BURNTBRIDGE POND	E221	00051	1607	45	1	08/27/79	6.05	EQ.M	94	34.60	3.13	1
2- 452	BUTLER POND	H264	00096	1035	57	6	08/30/79	6.26	EQ.M	83	36.50	3.58	1
4- 54	BUTTERFIELD LAKE	D173	01005	0278	23	4	08/11/78	8.00	COLOR	840	•	-	
2- 218	BUTTERNUT POND	D271	00166	0666	16	4	08/20/79	7.41	EQ.M	442	145.60	13.74	1
4- 344	CAGE LAKE	E203	00032	1815	22	1	07/31/75	5.25	UNKN		23.68	-	1
2- 97	CAMERAS POND	E242	13	2002	16	1	06/25/75	5.41	METER	7	14.75	1.30	2
4- 838	CANACHAGALA LAKE	G214	320	2152	22	7	06/24/75	5.40	METER	2	21.46	-	1
7- 717	CANADA LAKE	I222	00525	1550	18	2	08/29/79	5.20	EQ.M	-17	27.50	2.48	1
5- 267	CANARY POND	H234	13	2007	21	1	06/24/75	5.04	METER	-03	024.81	1.38	2
5- 669	CARRY POND	G231	6	2130	21	5	06/24/77	4.92	METER	-07	•	1.00	2
4- 747	CASCADE LAKE	F213	00096	1815	21	1	07/16/79	5.52	EQ.M	7	30.20	3.04	1
5- 644	CASCADE POND	F234	26	2139	21	1	06/24/75	6.11	METER	040	027.38	2.76	2
7- 865	CASTOR POND	H221	13	2295	21	5	06/24/75	4.65	METER	-15	028.85	1.80	2
7- 932	CAT LAKE	G223	00019	2360	21	1	08/04/77	6.30	UNKN		•	4.10	2
4- 329	CAT MOUNTAIN POND	E213	13	1725	45	5	07/09/78	4.97	METER	-5	22.10	-	3
3- 68	CATAMOUNT POND	C243	00006	1650	17	5	08/20/79	4.01	EQ.M	-69	13.10	0.57	1
3- 370	CATAMOUNT POND	D224	00102	1517	45	1	08/21/79	5.92	EQ.M	50	39.40	3.03	1
3- 290	CEDAR LAKE	D193	00064	0683	45	6	06/21/79	7.73	EQ.M	1223	909.00	144.38	1
5- 673	CEDAR LAKE	G223	00358	2437	21	1	07/16/79	6.31	EQ.M	27	20.10	2.75	1
4- 735	CEDAR POND	G202	6	1700	22	1	08/27/79	5.97	EQ.M	76	27.60	2.50	1
4- 889	CELLAR POND	G222	6	2980	21	5	07/17/79	3.55	EQ.M	-146	34.70	1.06	1
5- 559	CENTER POND	F254	13	2090	16	1	07/14/77	5.70	UNKN		•	-	1
4- 980	CHAMBER LAKE	G214	32	2049	22	1	06/24/75	5.46	METER	17	21.53	1.64	2
2- 276	CHAPEL POND	E252	00020	1610	16	1	07/22/75	5.80	COLOR		•		1
5- 280	CHARLEY LAKE	H232	00038	1693	21	1	08/28/79	6.29	EQ.M	95	33.90	3.17	1
4- 597	CHASE LAKE	F193	00134	1244	25	6	08/23/79	6.31	EQ.M	80	28.50	2.56	1
5- 164	CHASE LAKE	I232	64	1450	15	4	08/31/79	5.06	EQ.M	-20	22.50	2.06	1
5- 529	CHATEIMAC LAKE	G242	26	2261	57	1	06/24/75	6.63	METER	097	027.63	3.00	2
2- 20	CHAZY LAKE	B253	1606	1541	10	2	07/25/78	7.81	METER	302	51.90	-	3
5- 560	CHENEY POND	F251	00096	1705	16	1	08/30/79	6.36	EQ.M	99	45.60	3.34	1
5- 711	CHENEY POND	E243	6	2038	16	1	06/24/75	6.57	METER	99	29.41	3.00	2
4- 81	CHUB LAKE	B193	00098	0578	45	4	07/15/76	7.20	UNKN	700	•	-	1
4- 778	CHUB LAKE	F213	00038	1982	21	5	08/28/75	4.62	METER		75.17	-	1
5- 264	CHUB LAKE	H223	00019	1653	21	5	08/28/79	4.24	EQ.M	-44	20.90	1.48	1
4- 971	CHUB POND	G203	00045	1592	22	3	03/19/75	6.00	UNKN		•	-	1
3- 323	CHURCH POND	D212	00019	1548	45	1	08/21/79	5.72	EQ.M	28	24.60	2.20	1
4- 525	CLEAR LAKE	F211	00104	2011	22	7	06/24/75	5.16	METER	001	031.07	2.44	2
2- 70	CLEAR POND	D241	00102	1670	17	4	08/21/79	6.54	EQ.M	143	36.90	3.54	1
2- 358	CLEAR POND	F263	26	1418	16	1	07/19/78	7.31	METER	124	35.50	-	3
3- 85A	CLEAR POND	C233	00083	1560	17	3	08/21/79	5.53	EQ.M	-5	55.90	1.89	1
4- 312	CLEAR POND	E212	00013	1690	45	5	08/23/79	4.31	EQ.M	-42	22.40	2.00	1
5- 594	CLEAR POND	G241	00013	1915	21	1	07/24/79	5.86	EQ.M	62	30.90	3.25	1
6- 176	CLEAR POND	E213	00070	1750	21	1	08/27/79	5.90	EQ.M	44	26.90	2.85	1
4- 619	CLEVELAND LAKE	F193	00018	1237	25	5	01/30/75	4.80	UNKN		•	-	1
5- 228	CLOCKMILL POND	H223	00038	1805	21	5	08/29/79	4.02	EQ.M	-60	21.10	1.17	1
5- 286	COD POND	G244	00045	1516	57	4	08/29/79	6.07	EQ.M	79	28.20	2.99	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
2- 204	CONLEY LINE POND	D233	00001	1620	17	5	07/12/76	4.50	METER		.	-	1
2- 243	CONNERY POND	D254	00087	1659	16	3	08/20/79	6.27	EQ.M	97	39.90	4.29	1
4- 777	CONSTABLE POND	F213	00058	1910	21	5	08/28/75	4.64	METER		016.80	-	1
3- 205	COOLER POND	D241	00002	1650	17	7	08/02/77	6.00	UNKN		.	-	1
5- 233	COCHEY LAKE	H222	00007	1780	21	4	08/03/78	5.80	METER		019.00	-	1
2- 139	COPPERAS POND	D233	19	1573	17	4	07/14/78	7.87	METER	384	46.70	-	3
2- 234	COPPERAS POND	D254	19	1790	16	3	07/13/78	7.43	METER	139	32.80	-	3
4- 607	CORK POND	F193	00005	1280	25	3	01/30/75	5.00	UNKN		.	-	1
5- 626	CORNER POND	F233	00058	1720	21	4	08/22/79	5.84	EQ.M	31	27.60	2.94	1
5- 79	COSSAYUNA LAKE	I271	00659	0481	58	4	08/04/75	9.99	UNKN	171	.	-	1
4- 327	COWHORN POND	F213	19	1740	45	1	08/19/78	6.32	METER	26	21.30	-	3
5- 410	CRAB POND	F264	00013	1050	57	1	08/07/79	6.22	EQ.M	117	38.70	4.37	1
4- 375	CRACKER POND	F214	00019	1935	22	5	07/29/75	4.71	UNKN		29.10	-	1
4- 575	CRANBERRY POND	F214	00017	1934	22	5	08/23/79	3.86	EQ.M	-84	22.40	1.22	1
6- 319	CRANBERRY POND	F224	00026	1802	21	1	07/18/79	6.11	EQ.M	84	33.50	3.23	1
4- 309	CRANBERRY RESERVOIR	F212	06976	1486	45	4	08/23/79	5.56	EQ.M	16	28.90	2.51	1
5- 519	CRANE MOUNTAIN POND	G254	17	2600	57	1	06/24/75	6.49	METER	036	029.57	3.60	1
5- 421	CRANE POND	F264	00166	1081	16	2	08/30/79	6.29	EQ.M	86	35.70	4.04	1
4- 373	CROOKED LAKE	F211	00127	2048	22	5	06/24/75	4.64	METER	011	031.75	1.64	1
4- 480	CROPSEY POND	F202	00006	1910	22	5	08/29/75	4.42	METER		016.70	-	1
4- 481	CROPSEY POND	F202	00006	1910	22	5	07/28/75	4.75	UNKN		016.70	-	1
5- 598	CROTCHED POND	G232	00077	1820	21	1	06/10/78	6.30	METER		.	-	1
5- 507	CROWFOOT POND	F263	00032	1530	16	4	08/22/79	6.12	EQ.M	51	29.80	3.15	1
4- 595	CRYSTAL LAKE	F193	00083	1244	25	2	07/14/77	5.60	UNKN		.	-	1
5- 343	CRYSTAL LAKE	G261	51	950	57	4	08/06/78	7.56	METER	296	54.00	-	1
5- 654	CRYSTAL LAKE	F230	00026	1965	21	1	08/23/79	5.47	EQ.M	1	26.10	2.24	3
4- 313	CURTIS POND	F212	17	1830	45	5	07/26/76	4.90	UNKN	-80	.	-	1
5- 558	DAGGETT POND	G253	00026	0883	57	1	06/30/79	6.87	EQ.M	323	57.60	7.47	1
4- 319	DARNING NEEDLE POND	F213	00026	1700	45	3	07/30/75	6.04	UNKN		013.90	-	1
4- 750	DART LAKE	F213	00141	1757	22	5	08/23/79	4.45	EQ.M	-33	26.60	2.26	1
6- 208	DAWSON POND	E232	00006	1650	17	1	08/22/79	6.37	EQ.M	135	41.00	5.36	1
7- 846	DEBRAINE LAKE	H224	00013	2020	21	1	06/24/75	5.24	METER	006	020.85	1.50	2
4- 866	DEEP LAKE	G224	37	2588	21	5	08/07/78	4.66	METER	-40	25.40	-	3
7- 911	DEER LAKE	G213	00032	2375	21	7	06/24/75	5.21	METER	001	021.87	1.50	2
3- 251	DEER POND	D232	00017	1670	17	1	03/01/76	6.10	METER		.	-	1
3- 372	DEER POND	E221	00026	1520	45	7	06/28/78	7.20	METER		.	-	1
5- 689	DEER POND	E233	90	1670	16	1	07/24/78	6.95	METER	119	34.10	-	3
3- 73	DEER RIVER FLOW	C232	407	1458	17	4	08/21/79	6.87	EQ.M	347	66.50	6.82	1
5- 609	DEWITT POND	G223	00004	2380	21	1	06/01/78	5.80	METER		027.50	-	1
3- 164	DEXTER LAKE	C223	00128	1390	17	1	08/21/79	6.17	EQ.M	150	36.30	4.24	1
7- 759	DEXTER LAKE	I222	00032	1690	18	4	08/29/79	5.10	EQ.M	-31	23.80	1.84	1
7- 822	DIAMOND LAKE	H224	26	2657	21	5	06/24/75	4.76	METER	-11	027.62	1.50	2
6- 197	DIANA POND	F202	13	2053	22	5	06/24/75	4.60	METER	-17	30.94	1.16	2
5- 665	DISHRAG POND	F234	00013	2505	21	5	06/24/75	4.68	METER	-07	035.74	2.38	2
4- 515	DISMAL POND	F211	58	2077	22	5	06/24/75	4.45	METER	-31	30.71	0.94	2
5- 460A	DIX POND	E253	19	2230	16	1	06/24/75	6.45	METER	110	34.13	3.82	2
4- 264	DODGE POND	D203	00019	1011	45	4	08/18/77	6.50	UNKN	280	.	-	1
4- 31	DOG POND	E221	00019	1790	45	5	07/20/77	4.30	UNKN		.	-	1
7- 705A	DOLGEVILLE ROD & GUN CLUB POND	I213	00002	820	22	3	05/21/76	7.50	UNKN	360	.	-	1
6- 235	DUCK HOLE	E242	00058	2130	17	1	06/24/75	5.14	METER	001	028.10	2.44	2

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
5- 273	DUCK LAKE	I231	26	2310	21	5	06/24/75	4.57	METER	-21	027.84	1.10	2
3- 40	DUCK POND	C244	00064	1642	17	5	08/20/79	4.22	EQ.M	-64	12.10	0.86	1
2- 136	DUCK (ECHO) POND	D233	00019	1577	17	1	06/02/77	6.70	UNKN		.	-	1
2- 195	DUELL POND	D233	00002	1600	17	1	07/20/77	6.20	METER		.	-	1
5- 581	DUNK POND	F244	19	1555	16	1	07/26/78	7.70	METER	268	46.40	-	3
6- 80	EAGLE CRAG LAKE	E222	1536	1684	45	2	08/22/79	5.74	EQ.M	26	26.30	2.81	1
5- 438	EAGLE LAKE	F262	00422	0944	16	2	08/30/79	7.16	EQ.M	386	98.10	11.82	1
6- 306	EAGLE LAKE	F230	00166	1789	21	4	06/23/79	6.06	EQ.M	109	44.40	4.18	1
5- 476	EAGLES NEST POND	E263	00006	1570	16	1	07/31/79	5.80	EQ.M	55	36.30	-	1
7- 697	EAST CAROGA LAKE	I231	00026	1450	18	4	08/31/79	6.53	EQ.M	196	47.20	5.50	1
6- 135	EAST CHARLEY POND	E224	00026	1910	21	1	08/22/79	5.69	EQ.M	19	25.00	2.80	1
2- 138	EAST COPPERAS POND	D233	10	1572	17	5	07/14/78	4.55	METER	-32	28.50	-	3
3- 133	EAST POND	D231	00064	1730	17	1	08/21/79	6.15	EQ.M	94	31.40	3.51	1
4- 560	EAST POND	F221	00058	1962	21	6	08/28/79	5.38	EQ.M	1	31.00	2.78	1
4- 571	EAST POND	F213	00026	2129	22	5	06/24/75	4.56	METER	-17	027.95	1.38	2
4- 678	EAST POND	G202	00017	1820	22	5	08/09/76	4.90	UNKN		.	-	1
7-1062A	ECHO LAKE OR NORTH POND	H191	00094	1303	33	4	08/27/79	7.52	EQ.M	1489	165.10	-	1
4- 426.	EFFLEY POND	F192	00300	1161	25	4	06/28/77	5.50	UNKN		.	-	1
5- 129	EFNER LAKE	H254	00096	1167	46	4	08/30/79	5.99	EQ.M	50	39.50	3.36	1
4- 790	EIGHTH LAKE FULTON CHAIN	F224	00314	1791	21	2	06/28/79	6.50	EQ.M	244	56.40	6.59	1
4- 152	ELIJAH LAKE	E204	00025	1130	25	1	08/23/79	5.07	EQ.M	-16	29.00	2.82	1
5- 304	ELM LAKE	G233	00064	1750	21	4	08/29/79	6.70	EQ.M	290	48.50	6.23	1
4- 425	ELMER FALLS RESERVOIR	F192	00032	1108	25	4	08/23/79	5.40	EQ.M	-6	25.70	2.31	1
2- 157	EMBODY POND	D234	00004	1620	17	5	03/01/76	4.10	METER		.	-	1
4- 190	EMERALD LAKE	E203	00013	1890	22	6	07/18/77	5.00	METER		.	-	1
4- 585	FALLS POND	G221	00038	2490	21	7	08/28/79	6.31	EQ.M	59	33.00	3.32	1
4- 827	FAWN LAKE	G212	00019	1948	21	4	08/27/79	5.84	EQ.M	35	37.30	3.98	1
5- 247	FAWN LAKE	H231	00282	1701	21	2	08/12/76	6.30	UNKN		.	-	1
2- 222	FERN LAKE	D261	422	1223	10	4	07/23/78	7.52	METER	202	36.60	-	3
7- 777	FERRIS LAKE	H224	00122	1721	21	5	08/28/79	4.94	EQ.M	-40	19.80	1.64	1
4- 635	FIFTH CREEK POND	F203	00026	1717	22	5	08/23/79	4.13	EQ.M	-63	26.70	1.31	1
4- 977	FIRST LAKE BISBY CHAIN	G214	154	2028	22	1	06/24/75	6.58	METER	46	29.02	2.76	2
5- 625	FIRST LAKE ESSEX CHAIN	F233	00064	1598	16	1	08/23/79	6.62	EQ.M	263	55.10	7.74	1
4- 732A	FIRST LAKE FULTON CHAIN	G211	00736	1707	22	4	08/27/79	6.42	EQ.M	128	44.00	4.54	1
2- 123	FISH CREEK POND	D233	00134	1573	17	4	08/21/79	6.32	EQ.M	151	36.90	3.96	1
2- 124	FISH CREEK POND	D233	00077	1573	17	4	08/21/79	6.47	EQ.M	165	37.70	4.13	1
3- 149	FISH POND	D232	00102	1595	17	1	08/21/79	6.12	EQ.M	63	31.10	3.40	1
4- 614	FISH POND	F193	00064	1274	25	1	08/27/79	6.60	EQ.M	137	31.30	-	1
5- 552	FISH POND	E243	00019	[illegible]	16	1	06/24/75	6.76	METER	095	029.73	2.72	2
5- 287	FISH POND (LOWER)	G243	00019	1587	57	4	08/29/79	6.52	EQ.M	155	30.30	-	1
5- 288	FISH POND (UPPER)	G243	00019	1593	57	1	08/29/79	6.44	EQ.M	178	35.90	4.00	1
2- 407	FISHBROOK POND	G263	00032	1835	58	1	08/30/79	5.46	EQ.M	-17	31.80	3.22	1
4- 318	FISHPOLE POND	F213	00013	1719	45	1	08/23/79	5.54	EQ.M	19	29.90	3.29	1
5- 444	FLEMINGS POND	F261	00038	0997	16	4	08/30/79	6.42	EQ.M	207	44.40	5.82	1
2- 142	FLOODWOOD POND	D234	00237	1574	17	4	08/21/79	6.23	EQ.M	118	34.80	3.61	1
4- 664A	FLORENCE POND	G192	00004	1270	25	1	06/04/77	6.00	UNKN		.	-	1
4- 944	FORESTPORT RESERVOIR	H201	00102	1127	33	4	08/27/79	6.65	EQ.M	268	50.50	6.82	1
6- 276	FORKED LAKE	F222	01248	1743	21	2	08/28/79	5.49	EQ.M	11	28.70	2.58	1
4- 782D	FOURTH LAKE FULTON CHAIN	G211	2171	1997	22	2	09/07/78	6.72	METER	152	.	-	1
4- 821	FOX POND	G212	6	2130	22	5	06/24/75	4.76	METER	-5	24.36	1.50	2

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
4- 451	FRANCIS LAKE	F204	00134	1444	25	5	08/23/79	4.99	EQ.M	-26	23.10	2.09	1
5- 617	FRANK POND	F244	26	1695	16	1	07/26/78	6.82	METER	38	23.60	-	3
2- 76	FRANKLIN FALLS FLOW	D251	00435	1463	17	4	08/20/79	6.64	EQ.M	346	65.70	6.76	1
5- 365	FRIENDS LAKE	G251	00454	0913	57	4	01/03/77	7.20	UNKN		.	-	1
2- 121	FROG POND	D233	00002	1600	17	1	07/20/77	5.80	COLOR		.	-	1
7- 859	G LAKE	H221	00096	2030	21	1	07/25/78	5.20	METER		018.00	2.38	2
4- 376	GAL POND	E214	00013	1551	22	5	07/10/77	4.20	UNKN	140	.	-	1
7- 563	CALAWAY LAKE	I243	00518	0850	46	4	08/31/79	7.75	EQ.M	813	135.60	15.56	1
5- 520	GARNET LAKE	G243	00314	1462	57	4	08/29/79	6.54	EQ.M	183	40.70	4.39	1
2- 273	GIANT WASHBOWL	E261	6	2280	16	1	07/13/78	7.40	METER	159	34.70	-	3
4- 634	GIBBS LAKE	G202	00019	1858	22	6	08/27/79	5.79	EQ.M	55	25.00	2.31	1
5- 281	GILMAN LAKE	H232	00051	1673	21	2	08/28/79	6.01	EQ.M	43	30.10	2.93	1
2- 441	GLEN LAKE	H264	00320	0398	57	4	08/30/79	7.59	EQ.M	1560	259.00	28.74	1
5- 265	GOOD LUCK LAKE	I222	00038	1660	21	4	08/29/79	5.49	EQ.M	-13	18.50	1.88	1
5- 676	GOODNOW POND	F241	00058	1650	16	1	08/29/79	5.58	EQ.M	25	25.40	2.62	1
7- 913	GOOSE LAKE	G214	00013	2460	21	6	06/24/75	5.05	METER	-03	021.72	1.88	2
3- 261	GOOSE POND	D232	00060	1635	17	1	01/27/76	6.00	METER		.	-	1
4- 740	GOOSE POND	F214	00019	1771	22	4	08/23/79	5.61	EQ.M	18	34.40	2.78	1
5- 419	GOOSE POND	F264	00058	1178	16	3	08/30/79	8.26	EQ.M	99	37.90	4.59	1
4-1010	GOOSENECK LAKE	G213	6	2335	22	5	06/24/75	4.33	METER	-41	33.54	1.16	2
5- 442	GOOSENECK POND	F263	00077	1236	16	2	08/30/79	6.45	EQ.M	109	41.20	4.48	1
5- 157	GRANT LAKE	H233	00006	1495	21	4	08/03/78	5.20	METER		021.20	-	1
3- 171	GRASS POND	C231	00002	1260	17	6	07/25/77	5.00	COLOR		.	-	1
4- 188	GRASS POND	E203	00013	1770	22	5	08/23/79	3.90	EQ.M	-85	27.10	1.30	1
4- 642	GRASS POND	F203	00019	1760	22	5	08/23/79	3.94	EQ.M	-72	25.90	1.39	1
4- 706	GRASS POND	G202	00013	1790	22	1	08/11/76	5.30	UNKN		.		
3- 366	GRASS RIVER FLOW	D224	00269	1510	45	4	03/21/79	6.49	EQ.M	249	48.90	5.00	1
4- 366	GRASSY POND	E214	26	2003	22	5	06/24/75	4.64	METER	-15	30.22	2.08	2
5- 551	GRASSY POND	E243	00019	2045	16	4	06/24/75	6.00	METER	057	028.26	2.44	2
5- 127	GREAT SACANDAGA LAKE	H254	26656	0771	46	4	08/31/79	6.72	EQ.M	120	44.10	4.65	1
3- 157	GREEN POND	D232	19	1618	17	1	07/12/78	6.27	METER	-02	20.00	-	3
7-1055B	GRIFFISS AIRBASE REC POND	I191	00002	450	33	4	04/29/75	6.80	UNKN		.	-	1
2- 357	GRIZZLE OCEAN	F263	00019	1475	16	1	08/07/79	6.13	EQ.M	77	33.60	3.57	1
4- 377	GULL LAKE	E214	77	2030	22	1	06/24/75	5.37	METER	11	28.28	3.60	2
4- 717	GULL LAKE	G202	00013	1770	22	5	08/27/79	4.61	EQ.M	-35	19.20	1.70	1
4- 969	GULL LAKE	G203	00128	1773	22	4	08/27/79	5.40	EQ.M	2	21.90	1.77	1
5- 418	GULL POND	F264	13	1045	16	1	07/15/78	7.29	METER	128	33.10	-	3
2- 432	HADLOCK LAKE	H262	00275	0452	58	4	06/30/79	7.11	EQ.M	501	87.10	10.20	1
4- 831	HALL POND	F212	13	2250	22	5	06/24/75	4.60	METER	-20	27.32	1.00	2
5- 220	HAMILTON LAKE	H231	00141	1854	21	3	08/28/79	5.45	EQ.M	-2	26.50	2.41	1
4-1015	HARDSCRABBLE LAKE	G214	6	2075	22	6	06/24/75	5.33	METER	8	21.46	1.64	2
5- 716	HARKNESS LAKE	E243	00019	1950	16	1	08/27/79	5.80	EQ.M	26	28.10	3.36	1
4- 542	HARRINGTON POND	E213	5	1730	21	1	07/19/79	5.15	EQ.M	10	24.90	2.62	1
5- 680	HARRIS LAKE	F241	00275	1552	16	4	08/29/79	6.51	EQ.M	148	44.10	4.90	1
5- 189	HARRISBURG LAKE	H242	00077	1487	57	4	07/30/75	7.00	UNKN		.	-	1
4- 244	HARRY POND	G212	10	2105	22	5	06/24/75	4.38	METER	-37	30.27	-	1
7- 752	HART VLY LAKE	H223	00006	2215	21	5	06/24/75	4.53	METER	-22	032.60	1.50	2
5- 506	HATCHING POND	E263	00013	1590	16	1	08/22/79	5.90	EQ.M	46	31.00	2.92	1
4- 504	HAWK POND	F211	45	2117	22	5	06/24/75	4.66	METER	-16	31.98	1.64	2
6- 96	HAYMEADOW POND	D223	00019	1602	17	4	08/21/79	5.55	EQ.M	26	23.10	2.22	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5" QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
2- 264	HEART LAKE	E251	32	2170	16	1	07/22/78	6.61	METER	39	19.70	-	3
4- 298	HEATH POND	F211	00019	1442	45	1	08/23/79	6.08	EQ.M	155	52.40	4.85	1
6- 299	HELMS POND	F231	13	2230	21	4	06/24/75	6.10	METER	28	28.76	2 44	2
5- 715	HENDERSON LAKE	E243	00224	1808	16	1	08/22/79	5.10	EQ.M	-20	22.70	2.43	1
5- 388	HEWITT POND	F254	00179	1696	16	1	08/30/79	6.16	EQ.M	64	31.50	3.41	1
4- 505	HIDDEN LAKE OR HANKS POND	F211	00013	1803	22	5	06/23/79	3.99	EQ.M	-65	25.00	1.38	1
7- 799	HINCKLEY RESERVOIR	H203	02800	1225	22	4	08/27/79	6.65	EQ.M	309	55.10	6.84	1
4- 639	HITCHCOCK LAKE	F203	00045	1860	22	5	03/11/75	4.60	UNKN	140	.	-	1
4- 641	HITCHCOCK POND	F203	00019	1737	22	4	08/23/79	5.30	EQ.M	-7	25.20	1.95	1
4- 368	HITCHENS POND	E214	6	2010	22	5	06/24/75	4.71	METER	-2	26.26	1.80	2
2- 161	HOEL POND	D233	00454	1619	17	2	08/21/79	5.79	EQ.M	10	26.10	2.76	1
4- 247	HOG POND	F202	00006	1843	22	5	08/23/79	4.72	EQ.M	-28	31.70	2.61	1
5- 169	HOLMES LAKE	I231	00019	1850	18	5	08/31/79	4.25	EQ.M	-42	21.80	1.48	1
4- 884	HOME POND	G222	6	2135	21	4	06/24/75	5.74	METER	54	29.90	2.56	2
7- 877	HONNEDAGA LAKE	G213	00934	2187	22	5	06/24/75	4.91	METER	-10	027.56	1.60	2
4- 854	HORN LAKE	G213	38	2301	22	7	06/24/75	4.92	METER	-6	22.84	1.64	2
2- 118	HORSESHOE POND	D233	00090	1575	17	1	08/21/79	5.81	EQ.M	27	22.30	2.07	1
4- 210	HORSESHOE POND	F211	50	2067	22	5	06/24/75	4.66	METER	-16	33.64	-	1
4- 828	HORSESHOE POND	G211	13	2090	22	1	06/24/75	6.68	METER	77	33.44	3.44	2
5- 403	HORSESHOE POND	F253	00083	1255	16	4	08/30/79	6.50	EQ.M	186	43.00	3.94	1
5- 541	HOUR POND	G241	00032	2096	57	1	07/23/79	6.22	EQ.M	121	42.90	4.54	1
7- 769	HOUSE POND	H224	00019	1630	18	1	08/28/79	5.71	EQ.M	22	29.90	2.70	1
3- 269	HUMDINGER POND	D232	00003	1660	17	1	02/11/76	6.40	METER		.	-	1
5- 574	HUNTLEY POND	F244	58	1580	16	1	07/26/78	7.93	METER	420	60.00	-	3
4- 976	ICEHOUSE POND	G221	00007	1856	21	7	08/28/79	6.72	EQ.M	183	40.70	4.38	1
4- 647	INDEPENDENCE LAKE	F214	00051	1933	22	1	08/23/79	5.43	EQ.M	13	23.90	2.31	1
3- 51	INDIAN LAKE	C242	00307	1498	17	3	08/20/79	6.77	EQ.M	159	35.20	3.76	1
4- 38	INDIAN LAKE	E191	00173	0738	25	4	08/23/79	7.21	EQ.M	785	99.10	-	1
4- 852	INDIAN LAKE	G213	00090	2144	21	1	06/24/75	5.03	METER	006	024.76	2.20	2
5- 597	INDIAN LAKE	F233	04365	1650	21	2	08/29/79	6.05	EQ.M	31	28.50	2.81	1
7- 725	INDIAN LAKE	I231	00013	2010	18	5	06/24/75	4.72	METER	-14	024.62	1.30	2
4- 325	INDIAN MOUNTAIN POND	E212	00005	1725	45	3	09/09/75	6.00	UNKN		.	-	1
4- 40	INDIAN POND	E191	70	750	25	4	08/23/79	6.63	EQ.M	266	47.60	5.69	1
7- 853A	INDIGO LAKE	H224	00017	2240	21	5	06/24/75	4.85	METER	-13	026.32	1.50	2
3- 49	INGRAHAM POND	B243	00134	1643	17	1	08/20/79	6.30	EQ.M	100	28.10	3.51	1
7- 779	IRON LAKE	H223	00026	2045	21	5	08/28/79	4.03	EQ.M	-56	23.60	1.49	1
6- 164	IRON POND	F224	00026	1990	45	6	08/27/75	5.68	UNKN		005.60	-	1
7- 732	IRVING POND	I231	00134	1690	18	5	08/31/79	4.22	EQ.M	-46	22.30	1.55	1
2- 386	ISLAND POND	G261	00026	1338	57	3	08/30/79	6.82	EQ.M	226	59.00	7.52	1
2- 394	JABE POND	G262	00141	1309	57	1	06/30/79	6.63	EQ.M	122	39.30	4.11	1
4- 245	JAKES POND	F201	00019	1625	22	5	03/11/75	4.50	UNKN	140	.	-	1
6- 112	JENKINS POND	E231	301	1732	17	3	07/31/78	6.55	METER	75	.	-	3
5- 588	JERRY POND	G232	00013	1635	21	1	08/29/79	5.46	EQ.M	-6	22.20	-	1
7- 817	JERSEYFIELD LAKE	H213	00435	1933	22	5	08/27/79	4.13	EQ.M	-51	23.50	1.46	1
4- 583	JOCK POND	F213	00006	2110	22	5	06/24/75	4.58	METER	-23	031.70	1.16	2
5- 259	JOCKEY BUSH LAKE	H223	00038	1964	21	5	08/28/79	4.20	EQ.M	-37	24.60	1.70	1
5- 599	JOHN MACK POND	G232	00026	1745	21	1	08/29/79	5.98	EQ.M	33	30.30	3.09	1
5- 596	JOHN POND	G241	19	1622	21	1	07/23/79	6.15	EQ.M	109	32.70	3.93	1
5- 434	JOHNSON POND	F261	00090	1180	16	4	08/30/79	6.27	EQ.M	85	22.50	4.55	1
7- 853B.	JONES LAKE	H224	00013	2390	21	5	06/24/75	4.72	METER	-16	030.64	1.30	2

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
7- 875	JONES LAKE	G213	00049	2259	21	7	06/24/75	5.29	METER	-01	024.43	1.50	2
3- 206	JONES POND	D241	00160	1652	17	4	08/21/79	6.72	EQ.M	275	66.50	5.90	1
5- 143	KENNYETTO RESERVOIR	I243	00075	1390	46	4	06/03/75	6.70	UNKN		.	-	1
2- 325	KILKENNY BROOK POND	E262	00004	0575	16	4	08/15/77	7.00			.	-	1
5- 538A	KINGS FLOW	G241	00186	1710	21	1	08/29/79	6.39	EQ.M	100	34.20	3.81	1
7- 933	KINGS POND	G223	00002	2470	21	1	08/04/77	5.60	METER		.	-	1
2- 100	KIWASSA LAKE	D244	00287	1528	17	4	09/16/77	6.80	METER		.	-	1
7- 706	KLONDIKE RESERVOIR	I212	00019	1750	22	5	08/28/79	4.49	EQ.M	-36	20.70	1.56	1
5- 587B	LAKE ABANAKEE	F244	01018	1598	21	4	07/10/75	7.00	UNKN		.	-	1
5- 276A	LAKE ALGONQUIN	H232	00224	0982	21	4	08/28/79	6.76	EQ.M	273	61.00	6.42	1
5- 698	LAKE ANDREW	E243	13	2350	16	1	06/24/75	6.02	METER	20	32.34	3.56	2
4- 24	LAKE BONAPARTE	F191	01286	0768	25	4	06/01/76	7.90	UNKN		.	-	1
2- 199	LAKE CLEAR	D233	998	1611	17	2	07/29/78	7.62	METER	226	42.60	-	3
2- 106	LAKE COLBY	D244	00326	1555	17	3	08/21/79	6.89	EQ.M	456	131.50	8.44	1
5- 706	LAKE COLDEN	E254	38	2764	16	5	08/17/78	4.87	METER	-4	23.90	-	3
5- 645A	LAKE DURANT	F234	00320	1769	21	4	08/23/79	6.02	EQ.M	55	35.10	3.37	1
6- 245.	LAKE EATON	F231	00557	1721	21	2	05/23/79	5.45	EQ.M	48	37.10	-	1
2- 86.	LAKE FLOWER	D244	00339	1528	17	4	08/04/77	6.40	METER		.	-	1
5- 583	LAKE FRANCIS	F244	00098	1652	21	4	08/29/79	5.85	EQ.M	40	27.60	2.88	1
2- 367	LAKE GEORGE	F274	28160	0319	16	2	08/30/79	6.78	EQ.M	451	98.70	11.60	1
5- 713	LAKE JIMMY	E243	00032	1742	16	1	08/22/79	6.01	EQ.M	51	[illegible]	3.64	1
4- 883	LAKE KORA	G222	205	2103	21	4	06/24/75	6.46	METER	61	26.72	2.56	2
2- 55	LAKE KUSHAQUA	C243	00390	1669	17	2	08/20/79	6.52	EQ.M	302	41.80	5.58	1
4- 541	LAKE LILA	F212	01414	1715	21	1	08/06/79	5.54	EQ.M	18	28.80	2.64	1
5- 316	LAKE LUZERNE	H253	00096	0624	57	2	08/30/79	7.01	EQ.M	394	39.50	7.92	1
3- 165	LAKE OZONIA	C223	00397	1380	45	2	08/14/78	7.11	METER	191	034.30	-	3
2- 254	LAKE PLACID	D254	2803	1858	16	2	07/30/78	7.25	METER	118	35.50	-	3
5- 313	LAKE PLEASANT	H231	01440	1725	21	2	08/24/79	6.28	EQ.M	92	39.60	3.81	1
4- 739	LAKE RONDAXE	F214	00224	1720	22	4	08/23/79	5.94	EQ.M	60	30.70	-	1
5- 712	LAKE SALLY	F243	00017	1950	16	4	08/22/79	6.75	EQ.M	325	94.20	12.16	1
3- 28	LAKE TITUS	C232	00435	1397	17	1	08/21/79	6.56	EQ.M	222	47.20	4.92	1
6- 223	LATHAM POND	F233	00006	1730	16	1	06/06/75	6.46	UNKN		.	-	
6- 93	LEAD POND	D234	00083	1585	17	4	08/21/79	6.46	EQ.M	195	39.60	4.08	1
5- 332	LENS LAKE	H242	00102	1637	57	4	08/29/79	5.15	EQ.M	-13	23.20	1.79	1
6- 62	LEONARD POND	D224	00051	1465	45	4	07/13/77	6.55	METER		.	-	
5- 597A	LEWEY LAKE	G231	00365	1650	21	2	08/29/79	6.30	EQ.M	73	29.40	3.01	1
3- 60	LILLYPAD POND	B243	00020	1768	17	1	08/20/79	6.45	EQ.M	121	33.60	4.01	1
5- 354	LILY POND	G261	00058	1184	57	4	08/30/79	6.64	EQ.M	127	39.30	5.08	1
2- 108	LILYPAD POND	D244	00019	1590	17	1	08/21/79	6.62	EQ.M	282	58.10	5.99	-
4- 547	LILYPAD POND	F221	00019	1735	21	1	08/28/79	5.92	EQ.M	49	27.50	2.88	1
6- 25	LILYPAD POND	C213	00013	1470	45	1	06/16/76	6.50	UNKN	340	.	-	1
4- 826	LIMEKILN LAKE	G212	00461	1887	21	2	07/16/79	5.70	EQ.M	9	23.50	2.39	1
2- 315	LINCOLN POND	F262	00467	1031	16	4	08/16/77	7.00	UNKN		.	-	1
2- 109	LITTLE AMPERSAND POND	D244	00013	1610	17	1	08/04/75	5.80	UNKN		24.45	-	1
4- 586	LITTLE BIRCHES POND	F214	00005	2055	22	5	06 24/75	4.54	METER	-19	030.67	-	1
2- 130A	LITTLE BLACK POND	D234	00008	1579	17	1	07/21/77	5.90	METER		.	-	1
2- 191	LITTLE CLEAR POND	D233	00422	1597	17	3	08/21/79	6.65	EQ.M	238	42.80	4.36	1
4- 372	LITTLE CROOKED LAKE	E214	13	2090	22	5	06/24/75	4.57	METER	-22	34.44	-	1
4- 651	LITTLE DIAMOND POND	F214	13	2003	22	5	06/24/75	4.74	METER	-11	27.05	1.38	2
2- 126	LITTLE ECHO POND	D233	00002	1572	17	5	06/28/76	4.10	METER		.	-	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5" QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
2- 127A	LITTLE EGG POND	D234	00002	1587	17	7	08/02/77	5.90			.	-	1
4- 320	LITTLE FISH POND	E213	00004	1750	45	3	07/20/77	5.20	UNKN	140	.	-	1
2- 58	LITTLE HOPE POND	C244	00006	1710	17	1	07/27/77	6.00	COLOR		.	-	1
4- 650	LITTLE INDEPENDENCE POND	F214	00017	1945	22	5	08/23/79	4.51	EQ.M	-25	25.50	1.95	1
3- 267	LITTLE LONG POND	D232	00083	1654	17	3	08/21/79	5.74	EQ.M	16	28.40	2.88	1
5- 455	LITTLE MARSH POND	F252	00003	1590	16	1	08/30/79	6.03	EQ.M	53	29.60	3.72	1
7- 768	LITTLE METCALF POND	H224	00006	2060	22	5	07/23/75	4.81	METER		24.04	1.50	2
4- 890	LITTLE MOOSE LAKE	G222	96	2110	21	1	06/24/75	6.78	METER	126	28.97	2.44	2
5- 607	LITTLE MOOSE POND	G223	26	2273	21	1	07/11/77	5.00	UNKN		.	2.08	2
2- 141A	LITTLE NORTH WHEY POND	D234	00007	1600	17	5	06/30/76	4.20	METER		.	-	1
4- 664	LITTLE OTTER LAKE	G192	00045	1257	25	3	08/27/79	5.22	EQ.M	-5	19.20	1.68	1
4- 706	LITTLE PINE LAKE	G201	00013	1524	25	1	08/27/79	5.49	EQ.M	14	23.80	2.33	1
7- 855	LITTLE PINE LAKE	H221	13	2142	21	1	06/24/75	6.47	METER	056	023.40	-	1
2- 101	LITTLE PINE POND	D244	4	1600	17	4	05/04/78	7.88	METER	460	69.60	-	3
7- 880	LITTLE ROCK LAKE	H221	6	2235	21	5	06/24/75	4.89	METER	-04	024.95	3.00	2
5- 425	LITTLE ROCK POND (LILYPAD POND	F263	00017	1390	16	1	08/01/79	6.53	EQ.M	233	52.60	-	1
4-1003	LITTLE SALMON LAKE	H212	32	2226	22	5	06/24/75	4.99	METER	-02	024.11	1.38	2
4- 347	LITTLE SHALLOW POND	E214	6	1689	22	1	07/10/78	7.37	METER	152	41.80	-	3
2- 140	LITTLE SQUARE POND	D233	00102	1573	17	4	08/21/79	6.26	EQ.M	109	34.50	3.30	1
6- 120	LITTLE TUPPER LAKE	F223	02381	1717	21	1	08/22/79	5.12	EQ.M	35	30.90	3.14	1
6- 95	LITTLE WOLF POND	D224	00160	1550	17	4	08/21/79	6.37	EQ.M	136	34.50	3.73	1
4- 951	LITTLE WOODHULL LAKE	G214	00051	1860	22	4	08/22/79	5.69	EQ.M	34	26.50	2.30	1
5- 705	LIVINGSTON POND	F254	6	2775	16	7	07/20/78	6.19	METER	5	24.90	-	3
5- 197	LIZARD POND	G243	00019	1737	57	1	08/29/79	6.67	EQ.M	311	55.40	5.65	1
4- 610	LONG LAKE	F193	00006	1271	25	5	01/30/75	4.80	UNKN		.	-	1
4- 922	LONG LAKE	G204	00160	1467	33	4	05/05/76	6.00	UNKN	340	.	-	1
6- 241	LONG LAKE	F233	04090	1627	21	4	08/22/79	5.83	EQ.M	29	32.70	3.41	1
7- 823	LONG LAKE	H224	77	2090	21	5	06/24/75	4.75	METER	-15	027.88	1.30	2
2- 149	LONG POND	D234	00358	1602	17	2	08/21/79	6.28	EQ.M	91	32.20	3.01	1
2- 244	LONG POND	D254	00017	1690	16	1	08/20/79	6.37	EQ.M	96	41.10	4.62	1
3- 170	LONG POND	C231	00032	1247	17	5	08/21/79	3.94	EQ.M	-80	17.40	1.20	1
3- 257	LONG POND	D232	00013	1620	17	1	06/30/77	6.90	COLOR		.	-	1
3- 376B	LONG POND	D224	00050	1520	45	1	05/18/76	5.50	COLOR		.	-	1
4- 237	LONG POND	F201	00134	1350	25	5	08/23/79	4.35	EQ.M	-35	26.20	1.95	1
5- 310	LONG POND	G272	00038	1855	21	1	08/09/78	6.15	METER		012.00	-	1
6- 28	LONG POND	C213	00025	1330	45	1	06/19/76	6.50	UNKN	340	.	-	1
6- 113	LONG POND	F231	26	1972	17	1	08/22/79	5.45	EQ.M	5	28.20	2.62	1
7- 755	LONG POND	I222	00019	1730	18	5	07/31/78	4.70	METER		018.00	-	1
2- 284	LONG POND (ECHO LAKE)	D271	00314	0588	16	4	08/20/79	7.61	EQ.M	727	132.00	14.86	1
4- 196	LOON HOLLOW POND	F202	19	2090	22	5	06/24/75	4.52	METER	-27	39.98	1.16	2
2- 48	LOON LAKE	C253	00326	1712	17	4	08/20/79	6.40	EQ.M	167	39.10	4.18	1
5- 367	LOON LAKE	G252	00602	0868	57	4	08/30/79	6.91	EQ.M	268	72.40	6.80	1
2- 69	LOON POND	D241	00012	1683	17	1	09/18/76	5.22	METER		.	-	1
2- 272	LOST POND	D264	00002	2950	16	1	08/14/75	6.70	COLOR		.	-	1
2- 354	LOST POND	F263	00026	1553	16	3	08/14/75	6.65	UNKN		001.90	-	1
3- 199	LOST POND	D232	00013	1700	17	1	06/22/76	5.75	COLOR		.	-	1
4- 987	LOST POND	G222	00013	1915	21	5	07/17/79	4.81	EQ.M	-27	20.00	1.46	1
4- 925	LOST POND	G204	00006	1550	33	6	08/28/79	6.39	EQ.M	99	36.60	-	1
4- 879	LOST PONDS EAST	G221	00017	1913	21	1	07/24/78	6.30	METER		.	-	1
4- 878	LOST PONDS WEST	G221	00006	1913	21	4	07/24/78	6.60	METER		.	-	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
2- 276	LOWER AUSABLE LAKE	E253	00128	1965	16	1	08/22/79	5.90	EQ.M	54	27.80	3.16	1
6- 316	LOWER BROWNS TRACT POND	F224	00173	1766	21	4	08/28/79	6.08	EQ.M	68	33.40	3.32	1
2- 270	LOWER CASCADE LAKE	E252	26	2028	16	3	06/24/75	7.06	METER	158	66.26	5.64	2
3- 6	LOWER CHATEAUGAY LAKE	B243	00576	1309	17	2	07/23/76	7.60	COLOR		.	-	1
5- 801	LOWER DUG MOUNTAIN POND	G233	00026	1790	21	1	08/29/79	5.71	EQ.M	48	31.20	-	1
5- 256	LOWER LOOMIS POND	H223	6	2260	21	5	06/24/75	4.60	METER	-18	032.50	1.60	2
6- 238	LOWER PRESTON POND	E240	51	2150	16	1	06/24/75	5.10	METER	-1	30.02	2.44	2
2- 104	LOWER SARANAC LAKE	D244	02285	1533	17	4	06/08/76	6.80			.	-	1
6- 294	LOWER SARGENT POND	F223	00134	1797	21	1	08/28/79	6.14	EQ.M	100	30.90	3.34	1
4- 768	LOWER SISTER LAKE	F213	00087	1930	21	5	08/23/79	4.16	EQ.M	-56	23.30	1.93	1
3- 257A	LOWER ST REGIS LAKE	D232	00454	1619	17	4	08/21/79	6.65	EQ.M	273	53.70	4.75	1
5- 718	LOWER WELLFACE POND	F242	00006	3105	16	5	06/24/75	4.86	METER	009	023.66	1.60	2
3- 140	LYDIA POND	D231	00019	1570	17	1	07/13/77	6.00	COLOR		.	-	1
4- 498	LYON LAKE	F202	87	2001	22	5	06/24/75	4.48	METER	-28	33.38	1.38	2
4- 649	LYONS POND	F214	00006	2045	22	5	08/27/79	4.33	EQ.M	-46	24.70	1.41	1
2- 247	MALCOLM (HOLCOMB) POND	D254	00019	1687	16	1	08/20/79	6.55	EQ.M	168	41.10	-	1
2- 265	MARCY DAM POND	E251	00002	2380	16	1	06/04/75	5.59	UNKN		.	-	1
5- 398	MARION POND	F251	6	2270	16	5	07/20/78	4.80	METER		17.50	1.94	2
2- 238	MARSH POND	D254	00006	1630	16	1	11/09/79	6.00	EQ.M	68	51.10	5.26	1
5- 613	MASON LAKE	G234	00096	1796	21	1	08/29/79	6.42	EQ.M	186	59.10	5.22	1
3- 369	MASSAWEPIE LAKE	D224	00416	1512	45	2	08/21/79	6.42	EQ.M	181	42.40	4.15	1
2- 107	MCCAULEY POND	D244	00077	1563	17	4	08/21/79	6.22	EQ.M	108	32.40	3.19	1
2- 85	MCKENZIE POND	D243	00256	1660	16	1	08/21/79	5.94	EQ.M	75	36.70	4.16	1
3- 179A	MEACHAM LAKE	C233	01203	1552	17	4	08/21/79	6.04	EQ.M	177	43.30	4.46	1
2- 30	MEAD RESERVOIR	C262	00070	0523	10	2	08/20/79	7.73	EQ.M	1820	236.00	34.26	1
2- 203	MEADOW POND	D232	00013	1628	17	1	07/12/76	5.50	METER		.	-	1
5- 276	MECO LAKE	H234	13	2106	21	5	06/24/75	4.70	METER	-12	026.19	1.50	2
4- 756	MERRIAM LAKE	F213	19	2149	22	5	06/24/75	4.58	METER	-23	27.75	1.16	2
7- 900	METCALF CHAIN LAKE (UPPER)	H221	20	2400	21	5	06/24/75	4.98	METER	-05	025.50	2.00	2
7- 897	METCALF LAKE	H221	64	2397	21	5	06/24/75	4.92	METER	-03	026.80	1.70	2
7- 922	MICA LAKE (LITTLE)	G224	3	2375	21	5	06/24/75	4.86	METER	-07	022.51	1.30	2
4- 707	MIDDLE BRANCH LAKE	G202	00026	1622	22	1	08/27/79	5.96	EQ.M	62	26.90	2.50	1
5- 184	MIDDLE LAKE	H244	00032	1495	21	3	08/29/79	5.56	EQ.M	-2	20.70	2.03	1
5- 257	MIDDLE LOOMIS POND	H223	6	2250	21	5	06/24/75	4.64	METER	-15	031.00	1.50	2
2- 110	MIDDLE SARANAC	D244	01376	1536	17	4	07/03/75	7.00	COLOR		.	-	1
4- 704	MIDDLE SETTLEMENT LAKE	G202	00019	1726	22	5	08/29/75	4.55	METER		19.02	-	1
4- 199	MIDDLE SOUTH POND	F202	00077	1985	22	5	08/23/79	3.80	EQ.M	-77	26.60	1.33	1
3- 268A	MIKES POND	D232	00002	1660	17	1	02/11/76	5.90	METER		.	-	1
2- 225	MILITARY POND	C264	00024	1080	10	1	08/20/79	6.59	EQ.M	355	61.70	6.87	1
2- 318	MILL POND	E263	00038	1510	16	4	08/22/79	6.42	EQ.M	184	79.70	6.20	1
5- 381B	MINERVA LAKE	F254	00087	1234	16	4	08/30/79	7.12	EQ.M	673	109.40	15.75	1
6- 85	MINNOW POND	F222	17	1650	45	3	08/22/79	5.12	EQ.M	-20	19.40	1.88	1
6- 311	MINNOW POND	F231	96	2008	21	4	06/24/75	6.51	METER	78	40.38	3.24	2
2- 250	MIRROR LAKE	D254	128	1855	16	2	07/30/78	7.58	METER	297	90.90	-	3
7- 895	MISERY POND	H221	17	2310	21	5	06/24/75	4.85	METER	-09	024.59	1.70	2
4- 947	MITCHELL POND LOWER	G212	00045	1422	21	3	08/27/79	6.31	EQ.M	98	33.90	3.91	1
6- 312	MOHEGAN LAKE	C221	134	2020	21	2	06/24/75	5.98	METER	37	29.90	2.76	2
4-1012	MONUMENT LAKE	G213	13	2490	22	5	06/24/75	4.37	METER	-37	033.67	1.00	2
3- 292	MOON LAKE	D193	00013	0611	45	4	08/10/78	9.50	COLOR		.	-	1
6- 256	MOONSHINE POND	E223	19	2010	21	1	06/24/75	6.55	METER	88	29.16	3.00	2

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
2- 83	MOOSE POND	D243	00154	1548	16	2	08/21/79	6.07	EQ.M	118	40.20	4.32	1
5- 678	MOOSE POND	F243	45	2090	16	3	06/24/75	6.87	METER	109	27.02	2.44	1
6- 221	MOOSE POND	E244	00173	1781	16	1	08/22/79	6.34	EQ.M	126	35.40	4.16	1
6- 233	MOOSE POND	E242	26	2250	16	1	06/24/75	6.05	METER	023	029.84	2.76	1
5- 101	MOREAU LAKE	I261	00128	0341	46	4	08/30/79	7.24	EQ.M	570	112.90	15.66	1
4- 476	MOSHIER RESERVOIR	F202	00268	1639	22	6	08/23/79	5.01	EQ.M	-26	27.00	2.56	1
4- 746	MOSS LAKE	F213	00096	1758	22	1	08/27/79	6.03	EQ.M	61	34.60	3.42	1
4- 955	MOUNTAIN LAKE	G213	13	2570	22	5	06/24/75	4.36	METER	-38	035.44	1.24	2
2- 46	MOUNTAIN POND	C243	6	1680	17	5	07/22/78	4.70	METER	-17	14.40	-	3
2- 57	MOUNTAIN POND	C244	00026	1526	17	1	08/20/79	6.41	EQ.M	148	38.30	4.06	1
3- 198	MOUNTAIN POND	D232	00045	1634	17	1	08/21/79	6.03	EQ.M	61	46.50	3.49	1
4- 741	MOUNTAIN POND	F214	13	2005	22	7	06/24/75	6.46	METER	52	29.56	2.44	2
6- 230	MOUNTAIN POND	E241	26	2142	17	1	06/24/75	6.32	METER	79	27.86	2.76	2
3- 50	MOUNTAIN VIEW LAKE	C242	00198	1498	17	3	08/20/79	6.86	EQ.M	462	64.50	7.88	1
5- 381	MOXHAM POND	F254	00019	1650	16	4	08/30/79	6.93	EQ.M	294	71.40	6.95	1
6- 83	MT. ARAB LAKE	E222	141	1659	45	2	08/22/79	5.90	EQ.M	61	25.90	2.93	1
5- 216.	MUD LAKE	H234	00019	1730	21	1	08/28/79	5.10	EQ.M	-12	24.80	2.10	1
5- 316.	MUD LAKE	G234	00013	1730	21	4	08/29/79	6.95	EQ.M	317	54.50	6.57	1
7- 816	MUD LAKE	H213	00020	1290	22	1	07/01/75	6.00	UNKN	140	.	-	1
7- 929	MUD LAKE (WEST CANADA LAKE)	G223	134	2345	21	1	06/24/75	5.89	METER	043	024.97	2.56	2
2- 40	MUD POND	C253	00024	1185	10	1	08/20/79	7.19	EQ.M	763	101.20	14.79	1
2- 42	MUD POND	C254	00109	1370	10	1	08/20/79	6.02	EQ.M	70	34.70	3.73	1
2- 211	MUD POND	C264	00019	1428	10	4	08/20/79	6.53	EQ.M	175	41.60	4.31	1
2- 369	MUD POND	G271	00019	0570	58	4	08/30/79	7.24	EQ.M	904	115.40	17.38	1
3- 168	MUD POND	C222	00006	1254	17	1	08/21/79	7.48	EQ.M	1132	130.50	-	1
4-1008	MUD POND	C214	13	2095	22	6	06/24/75	5.12	METER	3	21.80	1.38	2
6- 246	MUD POND	F231	00096	1835	21	4	08/23/79	6.55	EQ.M	180	48.10	2.94	1
7- 788	MUD POND	H224	00006	2195	21	5	06/24/75	4.52	METER	-16	029.12	1.10	2
4- 701	MUDHOLE POND	G201	00006	1520	25	1	01/20/76	6.50	UNKN	280	.	-	1
5- 394	MULLER POND	F254	00077	1462	16	4	08/30/79	5.99	EQ.M	77	33.90	3.34	1
5- 486	MUNSON POND	E284	00019	1210	16	1	08/22/79	5.92	EQ.M	50	30.20	3.11	1
5- 213	MURPHY LAKE	H244	00032	1473	21	1	08/29/79	5.40	EQ.M	-14	25.10	2.42	1
4- 553	MUSKRAT POND	G224	00006	2190	21	1	06/24/75	5.76	METER	022	021.55	2.00	2
5- 577	NATE POND	F243	19	2014	16	1	06/24/75	6.51	METER	75	32.04	3.00	2
4- 529	NEGRO LAKE	F211	00141	1847	22	1	09/20/76	5.36	UNKN	080	.	-	1
3- 145	NELLIE POND	D231	00013	1625	17	1	08/01/77	6.20	UNKN		.	-	1
4- 718	NELSON LAKE	G202	00096	1598	22	4	03/11/75	6.00	UNKN	140	.	-	1
4- 556	NEW POND	F221	58	1845	21	6	06/24/75	5.40	METER	8	29.10	-	1
5- 501	NEW POND	E264	00096	1270	16	4	08/22/79	6.16	EQ.M	83	29.30	3.38	1
5- 694	NEWCOMB LAKE	F242	00504	1736	16	1	08/22/79	6.19	EQ.M	105	35.50	4.38	1
5- 505	NEWPORT POND	E263	00019	1270	16	4	08/22/79	6.49	EQ.M	163	46.00	4.45	1
2- 314	NICHOLS POND	E262	00077	1550	16	1	07/06/77	6.80	COLOR		.	-	1
4- 504	NICKS LAKE	G211	00205	1704	22	1	08/27/79	6.04	EQ.M	88	33.10	3.11	1
4- 292	NICKS POND	E211	13	1690	45	1	08/17/78	5.16	METER	0	19.80	-	3
4- 359	NICKS POND	E213	00013	1646	22	1	03/14/75	5.70	UNKN	136	.	-	1
7- 719	NINE CORNER LAKE	I222	00109	1870	18	7	08/29/79	4.32	EQ.M	-49	23.10	1.82	1
4-1007	NORTH LAKE	G214	00442	1823	22	1	03/11/75	5.70	UNKN		.	-	
2- 340	NORTH POND	E262	00025	1590	16	1	08/22/79	5.90	EQ.M	53	30.10	3.61	1
4- 563	NORTH POND	F221	00064	1861	21	6	03/28/79	6.02	EQ.M	82	39.30	3.28	1
5- 405	NORTH POND	F253	00064	1250	16	4	08/30/79	6.51	EQ.M	177	45.40	5.80	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
2- 141	NORTH WHEY POND	D234	00007	1600	17	5	02/25/76	3.80	METER		.		
4- 875	NORTHRUP LAKE	G224	13	2530	21	5	06/24/75	4.71	METER	-15	28.21	1.64	2
7- 861	NOTCH POND	H221	8	2480	21	1	06/24/75	6.75	METER	085	029.25	3.20	2
5- 365	OLIVER POND	F254	00077	1493	16	3	08/30/79	6.07	EQ.M	127	49.30	4.56	1
4- 323	OLMSTEAD POND	E213	00038	1689	45	5	08/23/79	4.93	EQ.M	-22	22.60	2.01	1
2- 64	OREGON POND	D242	00024	1680	17	4	08/21/79	5.50	EQ.M	-2	14.30	1.37	1
2- 90	OSEETAH LAKE	D244	00698	1528	17	4	08/04/77	6.70	UNKN		.	-	1
3- 202	OSGOOD POND	D241	00525	1651	17	4	08/21/79	6.54	EQ.M	236	50.00	4.91	1
4- 555	OSWEGO POND	F214	00006	2145	22	5	06/24/75	4.93	METER	005	.	1.50	2
4- 926	OTTER LAKE	G204	134	1516	33	4	05/07/78	6.94	METER	146	.	-	3
5- 666	OTTER LAKE	G223	26	2254	21	1	07/11/77	5.60	UNKN		.	-	1
7- 912	OTTER LAKE	G223	00019	2310	21	5	06/24/75	4.97	METER	-04	023.22	1.50	2
3- 128A	OTTER POND	D234	00013	1690	17	3	08/21/79	5.46	EQ.M	-5	23.90	-	1
4- 340	OTTER POND	E214	00026	1550	45	5	08/23/79	4.76	EQ.M	-25	23.10	1.88	1
4- 760	OTTER POND	F224	17	2130	21	4	06/24/75	5.02	METER	-3	42.29	2.44	2
4- 365	OVEN LAKE	E214	45	2003	22	5	06/24/75	4.59	METER	-13	32.10	2.08	2
2- 233.	OWEN POND	D254	00019	1690	16	1	08/20/79	6.03	EQ.M	109	46.10	5.35	1
5- 222.	OWL POND	H234	00006	1715	21	1	08/07/78	5.75	METER		017.00	-	1
5- 306	OWL POND	G233	00064	1934	21	3	08/29/79	5.88	EQ.M	18	24.40	2.49	1
2- 99	OWL (AVERILLS) POND	D244	00019	1560	17	1	07/14/76	5.35	UNKN		.	-	1
5- 252	OXBOW LAKE	H231	00282	1704	21	4	08/29/79	6.25	EQ.M	103	36.00	3.27	1
5- 427	OXSHOE POND	F264	00019	1280	16	1	07/31/79	5.93	EQ.M	90	33.10	3.71	1
5- 512A	PACK FOREST LAKE	G253	00026	0770	57	4	08/30/79	7.07	EQ.M	413	81.00	8.83	1
6- 207	PALMER POND	F232	00013	1715	17	1	06/05/75	6.50	COLOR		.	-	1
6- 167	PANTHER POND	E221	32	2095	45	6	06/24/75	5.12	METER	-5	23.67	2.20	2
5- 432	PARADOX LAKE	F261	00845	0816	16	2	08/30/79	6.68	EQ.M	286	61.60	8.11	1
2- 343	PARCH POND	E263	19	1510	16	4	08/06/78	6.96	METER	96	20.80	-	3
3- 91A	PARISHVILLE RESERVOIR	C212	00156	890	45	1	06/23/76	7.00	UNKN		.	-	1
2- 27	PATTERSON RESERVOIR (UPPER)	C262	00012	0596	10	6	08/20/79	7.21	EQ.M	734	101.30	-	1
4- 68	PAYNE LAKE	D184	00154	0345	23	4	05/06/75	7.50	UNKN	126	.	-	1
4- 620	PAYNE LAKE	F193	00019	1232	25	1	01/30/75	5.00	UNKN	140	.	-	1
7- 890	PEA POND	H221	6	2415	21	5	06/24/75	4.82	METER	-07	024.32	2.00	2
5- 433	PEAKED HILL POND	F261	00013	1158	16	4	08/30/79	6.16	EQ.M	81	37.50	4.48	1
5- 542	PEAKED MOUNTAIN POND	G241	26	2250	57	1	06/24/75	6.48	METER	066	025.76	3.00	2
6- 325	PELCHER POND	F224	00058	1613	21	5	08/28/79	4.57	EQ.M	-41	26.20	1.98	1
2- 351A	PENFIELD POND	F262	179	924	15	4	08/30/79	7.24	EQ.M	809	109.20	15.30	1
4- 443	PEPPERBOX POND	F202	00019	1864	22	5	08/23/79	3.69	EQ.M	-102	28.50	0.98	1
5- 412	PHARAOH LAKE	F264	00442	1146	16	1	08/30/79	6.25	EQ.M	109	42.30	5.12	1
6- 195	PICKEREL POND	E232	00019	1570	17	4	08/22/79	6.47	EQ.M	233	51.10	5.93	1
4- 932	PICO LAKE	G212	26	2053	22	5	06/24/75	4.38	METER	-38	33.39	1.00	2
6- 65	PIERCEFIELD FLOW	E222	365	1540	45	4	08/22/79	6.07	EQ.M	78	36.60	3.59	1
4- 779	PIGEON LAKE	F213	45	2076	21	5	06/24/75	4.66	METER	-22	32.31	1.64	2
6- 278	PILGRIM POND	F221	13	2473	21	5	06/24/75	4.74	METER	-3	34.45	2.20	2
7- 938	PILLSBURY POND	G223	96	2493	21	4	06/24/75	5.43	METER	006	023.88	2.20	2
2- 398	PINE LAKE	G274	00076	0959	58	4	08/30/79	6.69	EQ.M	238	53.20	7.25	1
4- 699	PINE LAKE	G201	00032	1538	25	1	08/27/79	5.82	EQ.M	66	26.00	2.71	1
5- 655	PINE LAKE	F233	00122	1590	21	1	07/25/79	6.62	EQ.M	304	51.50	7.81	1
7- 724	PINE LAKE	I222	00160	1570	18	4	08/29/79	5.06	EQ.M	-26	21.30	1.97	1
5- 572	PINE MOUNTAIN POND	F244	00013	1646	21	1	07/26/79	6.07	EQ.M	106	34.50	3.48	1
3- 368	PINE POND	D224	00017	1510	45	7	05/19/76	6.00	COLOR	140	.	-	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
5- 470	PINE POND	F261	00064	1055	16	4	08/22/79	6.28	EQ.M	107	29.10	4.41	1
5- 234	PISECO LAKE	H222	12848	1661	21	2	08/29/79	5.85	EQ.M	43	29.70	2.68	1
4- 662A	PITCHER POND	G192	00005	1200	25	5	01/30/75	4.50	UNKN		.	-	1
6- 57A	PITCHFORK POND	D223	00032	1605	17	1	06/21/79	5.41	EQ.M	5	21.40	2.09	1
7- 745	PLEASANT LAKE	I222	00243	1635	18	4	08/29/79	5.42	EQ.M	7	24.90	2.44	1
3- 62	PLUMADORE POND	C242	00102	1705	17	1	08/20/79	6.57	EQ.M	103	34.70	3.35	1
4- 581	POCKET POND	F214	00006	2235	22	5	06/24/75	4.30	METER	-45	037.70	1.16	2
2- 120	POLLIWOG POND	D233	00186	1594	17	3	11/04/77	6.30	COLOR		.	-	1
7- 919	POOR LAKE	G224	00019	2390	21	5	07/31/78	4.35	METER		029.00	1.50	2
3- 274	POTTER POND	D232	00003	1630	17	1	02/24/76	5.20	METER		.	-	1
5- 544	PRIER POND	F243	00013	1870	21	1	08/29/79	6.91	EQ.M	270	58.90	8.38	1
7- 937	PUDDLE HOLE POND	G223	13	2480	21	4	06/24/75	6.39	METER	060	024.84	2.20	2
5- 589	PUFFER POND	G241	00038	2184	57	1	08/09/78	6.50	METER		023.00	2.72	2
2- 355	PUTNAM POND	F263	00179	1308	16	4	08/30/79	6.32	EQ.M	98	36.20	4.02	1
4- 795	QUIVER POND	G212	00019	1737	22	1	08/27/79	5.54	EQ.M	0	21.90	1.91	1
6- 22A	RAINBOW FALLS RESERVOIR	C213	00717	1181	45	4	08/21/79	6.02	EQ.M	78	35.00	3.28	1
2- 65	RAINBOW LAKE	D241	00371	1670	17	4	08/21/79	6.78	EQ.M	217	44.80	4.66	1
2- 66	RAINBOW LAKE INLET	D241	00112	1668	17	4	08/21/79	6.66	EQ.M	178	40.60	3.77	1
4- 544	RAINER POND	E213	00013	1750	21	1	07/19/79	5.21	EQ.M	12	24.60	2.37	1
5- 556	RANKIN POND	F243	00013	1901	16	1	08/29/79	5.59	EQ.M	8	44.10	3.08	1
6- 293	RAQUETTE LAKE	F222	05274	1762	21	2	08/28/79	5.88	EQ.M	43	36.00	3.15	1
2- 186	RAT POND	D233	00032	1615	17	1	08/21/79	5.68	EQ.M	19	24.80	2.12	1
4- 496	RAVEN LAKE	F202	00122	1925	22	5	08/23/79	3.75	EQ.M	-88	27.80	1.24	1
4- 573	RAZORBACK POND	F214	00013	2190	22	1	06/24/75	5.49	METER	050	023.78	1.94	2
7- 771	REDLOUSE LAKE	H224	00013	1730	21	5	08/29/79	4.21	EQ.M	-45	25.00	1.65	1
5- 652	RICH LAKE	F241	384	1564	16	4	07/27/78	7.25	METER	111	32.80	-	3
4- 354	RILEY POND LOWER	E214	00019	1930	22	5	07/19/77	4.30	METER	140	.	-	1
4- 355	RILEY POND UPPER	E214	00013	1990	22	5	07/20/77	4.40	METER		.	-	1
4- 189	ROCK LAKE	E203	00064	1802	22	5	08/23/79	4.04	EQ.M	-73	27.60	1.51	1
4- 538	ROCK LAKE	F212	00188	1790	22	1	09/08/76	5.57	UNKN	220	.	-	1
5- 229	ROCK LAKE	H223	00026	1810	21	5	06/30/79	4.20	EQ.M	-58	21.00	1.46	1
5- 275	ROCK LAKE	H234	00006	1917	21	5	08/02/78	4.65	METER		017.00	-	1
5- 637	ROCK LAKE	F232	00179	1713	21	4	06/23/79	6.12	EQ.M	101	39.20	3.76	1
5- 309	ROCK POND	G233	00032	1865	21	4	08/09/78	5.40	METER		019.50	-	1
5- 424	ROCK POND	F263	00058	1383	16	1	06/30/79	5.95	EQ.M	49	45.20	4.55	1
5- 586	ROCK POND	F244	00006	1695	21	1	07/26/79	5.24	EQ.M	2	17.50	1.45	1
5- 645	ROCK POND	F234	00064	1769	21	4	08/23/79	5.78	EQ.M	25	29.70	2.78	1
6- 129	ROCK POND	F221	00294	1723	21	1	08/28/79	5.00	EQ.M	-19	27.00	2.34	1
6- 196	ROCK POND	E232	26	1595	17	1	07/16/78	6.99	METER	73	35.40	-	3
2- 166	ROLLINS POND	D234	00442	1575	17	4	08/21/79	6.37	EQ.M	110	35.50	3.39	1
4- 568	ROSE POND	F212	00045	1781	21	6	08/23/79	5.02	EQ.M	-16	25.60	2.30	1
5- 569	ROSS POND	F244	00032	1750	21	1	07/25/79	5.36	EQ.M	4	26.20	2.54	1
2- 256	ROUND LAKE	F251	45	2082	16	1	06/24/75	6.61	METER	51	34.10	3.50	2
4- 161	ROUND LAKE	F204	00051	1319	45	5	08/23/79	4.82	EQ.M	-8	22.30	2.06	1
7-1089	ROUND LAKE	J252	00320	0155	46	4	08/11/77	9.30	UNKN	070	.	-	1
2- 329	ROUND POND	E264	26	1730	16	1	07/19/78	7.02	METER	69	21.50	-	3
4- 907	ROUND POND	G204	00013	1530	33	1	01/28/75	6.00	UNKN	140	.	-	1
5- 489	ROUND POND	E264	00026	1190	16	4	08/22/79	6.27	EQ.M	124	36.60	4.59	1
5- 521	ROUND POND	G243	00070	1682	57	4	08/29/79	6.67	EQ.M	226	46.70	5.16	1
5- 590	ROUND POND	G241	00032	1750	21	4	08/10/78	5.20	METER		019.50	-	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5" QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
5- 687	ROUND POND	E233	00224	1673	21	1	08/22/79	6.12	EQ.M	78	33.00	3.78	1
4- 750	RUDDERMANS QUARRY POND	D194	00007	0440	45	4	08/16/77	8.00	UNKN		.	-	1
4- 774	RUSSIAN LAKE	F213	00026	1655	21	5	08/23/79	4.04	EQ.M	-59	28.60	1.84	1
5- 314	SACANDAGA LAKE	H231	00621	1726	21	2	08/24/79	6.29	EQ.M	105	38.70	3.96	1
4- 736	SAFFORD POND	F214	00059	1762	22	1	08/23/79	5.33	EQ.M	7	28.70	2.60	1
6- 313	SAGAMORE LAKE	F224	00179	1904	21	2	06/10/76	6.00	UNKN		.	-	1
3- 156A	SAINT REGIS POND	D233	00386	1616	17	1	08/21/79	5.95	EQ.M	35	28.30	2.93	1
4- 517	SALMON LAKE	F211	00102	1721	22	5	06/17/76	4.85	UNKN		.	-	1
6- 247	SALMON POND	F231	63	2070	21	1	07/24/75	5.00	UNKN		.	2.20	2
7- 926	SAMPSON LAKE	G223	00049	2398	21	1	08/03/77	6.50	UNKN		.	5.90	2
4- 191	SAND LAKE	E203	00058	1796	22	5	08/23/79	4.72	EQ.M	-30	26.20	2.09	1
4- 981	SAND LAKE	G214	00314	1825	22	5	08/27/79	4.71	EQ.M	-45	21.90	1.91	1
5- 210	SAND LAKE	H243	00052	1732	46	1	08/29/79	5.82	EQ.M	27	27.30	2.67	1
5- 225	SAND LAKE	H223	00115	1774	21	5	08/28/79	4.25	EQ.M	-58	20.90	1.41	1
4- 436	SAND POND	F201	00077	1673	25	5	08/23/79	4.16	EQ.M	-51	22.10	1.58	1
5- 457	SAND POND	F251	00097	1832	16	1	08/30/79	6.08	EQ.M	211	33.90	5.16	1
5- 710	SANFORD LAKE	E243	00230	1718	16	4	08/22/79	6.46	EQ.M	163	111.80	10.25	1
3- 207	SANTA CLARA FLOW	C231	00240	1329	17	3	08/21/79	6.73	EQ.M	325	55.00	5.62	1
5- 374	SCHROON LAKE	G252	04128	0807	16	2	06/15/77	6.20	COLOR		.	-	1
5- 241	SCOTCH LAKE	H222	00006	2170	21	6	08/26/75	5.30	METER		.	1.80	2
2- 261	SCOTT POND	E242	6	3190	16	5	06/24/75	4.75	METER	-6	27.20	1.94	2
4- 976	SECOND LAKE BISBY CHAIN	G214	109	2028	22	1	06/24/75	5.98	METER	16	24.63	2.20	2
2- 102	SECOND POND	D244	00198	1533	17	4	08/21/79	6.24	EQ.M	164	45.20	4.46	1
4- 757B	SEVENTH LAKE FULTON CHAIN	G221	00851	1786	21	2	08/28/79	6.36	EQ.M	117	49.00	4.82	1
6- 324	SHALLOW LAKE	F224	00256	1608	21	4	07/17/79	5.83	EQ.M	41	28.70	2.81	1
2- 351	SHERMAN LAKE (TONER POND)	F262	00038	1075	16	1	08/30/79	6.91	EQ.M	428	65.20	2.85	1
4- 565	SHINGLE SHANTY POND	F212	00083	1900	21	1	08/23/79	5.53	EQ.M	5	25.40	.31	1
5- 492	SHINGLETREE POND	E264	00002	0985	16	1	08/15/78	6.80	METER		190.00		1
2- 73	SILVER LAKE	C253	832	1393	10	4	07/25/78	7.52	METER	184	41.40	-	3
3- 351	SILVER LAKE	E212	00121	1483	45	4	08/23/79	6.81	EQ.M	187	56.40	4.78	1
4- 580	SILVER LAKE	F214	00058	2102	22	5	06/24/75	4.87	METER	-13	027.40	1.64	2
5- 270	SILVER LAKE	H234	00064	2072	21	5	06/24/75	4.92	METER	006	029.91	4.90	2
3- 260	SIMKINS POND	D232	00002	1650	17	1	01/29/76	5.90	METER		.	-	1
4- 499	SLIM POND	F202	13	2005	22	6	06/24/75	5.28	METER	14	24.27	1.94	2
6- 260	SLIM POND	F223	00262	1711	21	4	08/22/79	5.94	EQ.M	2	30.80	3.11	1
6- 302	SLIM POND	F223	6	2126	21	1	06/24/75	6.07	METER	31	22.45	2.20	2
2- 224	SLUSH POND	C264	00045	1244	10	1	08/20/79	6.59	EQ.M	247	51.20	5.50	1
3- 245	SLUSH POND	D232	00013	1573	17	1	07/15/77	7.00	COLOR		.	-	1
4- 288	SLY POND	G222	26	2672	21	5	07/18/79	3.54	EQ.M	-124	29.20	1.08	1
7- 882	SNAG LAKE	H221	13	2353	21	5	06/24/75	4.88	METER	-06	025.64	1.30	2
4-1011	SNYDER LAKE	G213	19	2410	22	5	06/24/75	4.38	METER	-35	32.56	1.16	2
4- 511	SODA POND	F202	19	2115	22	5	06/24/75	4.68	METER	-22	27.76	1.10	2
4- 431	SOFT MAPLE DAM POND	F201	00096	1255	25	5	06/23/79	4.80	EQ.M	-20	25.70	2.39	1
4- 434	SOFT MAPLE RESERVOIR	F201	00326	1288	25	2	06/17/75	6.20	UNKN	140	.	-	1
5- 315	SOUND LAKE	G234	00019	1730	21	4	06/29/79	6.33	EQ.M	106	36.10	4.28	1
4- 746	SOUTH CREEK LAKE	E204	00032	1130	45	3	06/10/77	6.40	METER		.	-	1
4-1004	SOUTH LAKE	G214	499	2018	22	1	09/07/79	5.31	EQ.M	6	21.10	-	1
7- 930	SOUTH LAKE (WEST CANADA LAKE)	G223	96	2345	21	5	06/24/75	4.98	METER	002	024.22	2.00	2
5- 303	SOUTH PINE LAKE	G233	00013	1765	21	5	08/29/79	4.93	EQ.M	-44	26.10	2.60	1
4- 582	SOUTH POND	F214	00025	2046	22	5	06/24/75	4.72	METER	-13	028.46	1.16	2

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
4- 772	SOUTH POND	F221	26	2001	21	5	06/24/75	4.93	METER	-7	25.86	1.94	2
5- 312	SOUTH POND	G244	6	2310	21	1	06/24/75	5.68	METER	30	30.12	2.80	2
6- 245	SOUTH POND	F231	00442	1767	21	5	08/23/79	4.51	EQ.M	-44	29.40	2.18	1
7- 760	SPECTACLE LAKE	I222	00166	1730	18	4	08/29/79	5.11	EQ.M	-24	23.30	1.62	1
5- 408	SPECTACLE POND	F264	00038	1165	16	1	07/31/79	6.88	EQ.M	418	70.80	11.66	1
7- 951	SPLIT ROCK LAKE	H221	00013	2165	21	1	08/29/79	5.91	EQ.M	22	24.90	2.01	1
7- 905	SPOON LAKE	H221	5	2540	21	5	06/24/75	4.34	METER	-44	035.95	1.24	2
5- 662	SPRAGUE POND	F234	00064	1840	21	3	08/27/79	6.35	EQ.M	95	37.30	3.85	1
5- 414	SPRINGHILL POND (LOWER)	F263	00026	1818	16	1	08/01/79	5.35	EQ.M	6	27.50	2.43	1
5- 416	SPRINGHILL POND (UPPER)	F263	00007	1840	16	1	08/01/79	5.80	EQ.M	18	35.40		1
7- 706A	SPRUCE LAKE	I212	00550	1360	22	4	08/28/79	6.53	EQ.M	216	52.40	6.99	1
7- 908	SPRUCE LAKE	G223	00179	2378	21	1	07/16/79	5.06	EQ.M	6	21.50	1.68	1
5- 232	SPY LAKE	H222	00358	1656	21	4	08/30/79	5.54	EQ.M	38	26.80	2.33	1
2- 125	SQUARE POND	D233	00141	1573	17	4	08/21/79	6.35	EQ.M	139	35.80	3.77	1
4- 450	SQUAW LAKE	G221	00083	2115	21	1	06/24/75	5.84	METER	012	026.26	2.56	2
5- 580	SQUIRREL POND	F244	00006	1535	21	1	07/24/79	6.53	EQ.M	241	46.00	6.92	1
4- 281	STAR LAKE	E202	00237	1450	45	2	06/23/79	6.37	EQ.M	116	44.10	3.51	1
5- 643	STEPHEN'S POND	F234	00077	1952	21	1	08/27/79	5.82	EQ.M	49	29.90	2.96	1
6- 29	STERLING POND	C224	00006	1364	45	3	06/15/76	7.50	UNKN	680	.	-	1
7- 730	STEWART LAKE	I231	00026	1970	18	5	08/31/79	4.25	EQ.M	-48	22.40	1.20	1
4- 493	STILLWATER RESERVOIR	F202	06195	1680	22	2	08/23/79	5.07	EQ.M	-19	25.10	2.28	1
4- 836	STINK LAKE	G212	00006	1910	22	3	08/27/79	5.91	EQ.M	52	24.30	2.16	1
7- 721	STONER LAKE MIDDLE	I222	00070	1650	18	4	07/14/75	7.00	UNKN		.	-	1
7- 723	STONER LAKE (EAST)	I222	00026	1650	21	4	07/16/75	7.00	UNKN		.	-	1
7- 722	STONER LAKE (WEST)	I222	00070	1650	18	4	07/15/75	7.00	UNKN		.	-	1
6- 191	STONY CREEK PONDS	E232	00186	1547	17	4	08/22/79	6.36	EQ.M	168	43.60	4.95	1
4- 617	STONY LAKE	F204	00077	1335	25	4	07/23/76	5.23	UNKN		.	-	1
5- 557	STONY POND	F254	64	2078	16	5	07/14/77	4.70	UNKN		.	2.72	2
6- 264	STONY POND	E223	00109	1710	21	4	06/22/79	5.78	EQ.M	46	31.00	2.96	1
5- 587	STONYSTEP POND	F244	00006	1695	21	4	08/29/79	5.09	EQ.M	-5	22.00	1.88	1
4- 353	STREETER FISH POND	E214	00013	1910	22	5	07/28/75	4.81	METER		32.00	-	1
4- 285	STREETER LAKE	E203	00051	1486	45	3	07/15/75	7.00	UNKN		.	-	1
7- 870	SUCKER POND	H212	00017	2372	22	5	06/24/75	4.69	METER	-15	023.59	0.90	2
7- 472	SUGARLOAF POND	J264	00006	0140	46	4	08/03/76	7.80	UNKN	136	.	-	1
4- 527	SUMMIT POND	F211	13	2067	22	5	06/24/75	4.70	METER	-15	32.67	2.00	2
2- 158	SUNDAY POND	D233	00010	1590	17	1	06/02/77	6.70	UNKN		.	-	1
2- 117	SUNRISE POND	D233	00010	1572	17	5	06/28/76	4.75			.	-	1
4- 487	SUNSHINE POND	F202	00077	1965	22	5	08/23/79	3.92	EQ.M	-74	21.80	1.10	1
4- 978	SYLVAN POND LOWER	G214	13	2042	22	1	06/24/75	6.59	METER	69	29.77	2.20	2
4- 979	SYLVAN POND UPPER	G214	13	2046	22	1	06/24/75	6.61	METER	50	31.35	2.88	2
4- 88	SYLVIA LAKE	E191	00314	0654	45	2	08/21/79	7.40	EQ.M	1130	240.00	35.29	1
7- 862	T LAKE	H222	51	2467	21	5	06/24/75	4.82	METER	-06	027.54	1.50	2
6- 171	TAMARACK POND	E213	00013	1778	45	7	01/21/78	5.30	METER	540	.	-	1
2- 227	TAYLOR POND	D252	00813	1392	10	3	06/25/77	6.80	METER		.	-	1
5- 186	TENANT LAKE	H243	00083	1663	46	1	08/29/79	6.26	EQ.M	98	38.60	3.08	1
4- 567	THAYER LAKE	F212	00141	1783	21	1	08/27/79	6.05	EQ.M	97	31.70	2.99	1
4- 975	THIRD LAKE BISBY CHAIN	G214	45	2021	22	1	06/24/75	6.00	METER	23	23.81	2.40	2
4- 738	THIRSTY POND	F214	38	2124	22	4	06/24/75	5.18	METER	-2	23.70	1.94	2
5- 540	THIRTEENTH LAKE	G242	00237	1674	57	1	08/29/79	6.37	EQ.M	93	37.20	3.82	1
5- 402	THURMAN POND	F253	00096	0890	16	4	08/30/79	6.72	EQ.M	344	70.90	8.24	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED & P#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
4- 446	TIED LAKE	F202	00006	1870	22	4	08/23/79	5.66	EQ.M	23	23.60	2.15	1
5- 641	TIRRELL POND	F232	00167	1918	21	1	07/23/79	5.69	EQ.M	18	32.90	2.74	1
4- 369	TOAD POND	E214	00019	1910	22	5	08/23/79	3.90	EQ.M	-98	29.10	1.34	1
2- 242	TOM PECK POND	D254	00006	1710	16	1	08/20/79	6.37	EQ.M	180	48.30	3.70	1
7- 609	TOMKETTLE LAKE	H214	00013	1374	22	1	07/01/75	6.00	UNKN		.	-	1
4- 306	TOOLEY POND	D214	00039	1510	45	3	06/24/76	7.00	UNKN	420	.	-	1
3- 371	TOWNLINE POND	E221	00038	1520	45	1	06/28/78	5.90	METER		.	-	1
2- 146	TRACK POND	D234	00002	1620	17	5	03/01/76	4.90	METER		.	-	1
6- 166	TRIANGLE POND	E221	13	2010	45	6	04/24/75	5.53	METER	8	21.43	1.94	2
2- 379	TROUT LAKE	C264	237	787	57	4	08/02/78	7.67	METER	242	59.30	-	3
3- 293	TROUT LAKE	D193	00371	0746	45	2	08/21/79	6.92	EQ.M	334	614.00	6.92	1
5- 260	TROUT LAKE	H223	00017	1650	21	5	08/28/79	4.76	EQ.M	-24	21.70	1.50	1
7- 793	TROUT LAKE	H224	51	2176	21	5	06/24/75	4.91	METER	-01	026.64	2.00	2
2- 306	TROUT POND	D262	00037	0858	16	4	08/20/79	6.77	EQ.M	336	67.00	7.43	1
6- 146	TROUT POND	E224	00154	1750	45	1	08/22/79	5.24	EQ.M	-17	24.70	2.44	1
3- 155	TUESDAY POND	D232	00005	1650	17	1	08/01/77	5.20	METER		.	-	1
6- 109.	TUPPER LAKE	E222	03762	1545	17	2	08/22/79	5.76	EQ.M	33	28.20	3.21	1
5- 538.	TWENTYNINTH POND	F243	00013	2010	16	1	06/24/75	6.04	METER	033	020.74	2.08	2
4- 569	TWIN LAKE	G224	19	2657	21	5	06/24/75	4.64	METER	-23	30.56	-	1
4- 870	TWIN LAKE	G224	26	2660	21	5	06/24/75	4.58	METER	-23	27.82	1.00	2
4- 860	TWIN LAKE UPPER	G213	6	2430	22	5	06/24/75	4.33	METER	-45	033.95	1.10	2
7- 857	TWIN LAKE (NORTH)	H222	3	2590	21	5	06/24/75	4.93	METER	-06	025.60	1.30	2
5- 294	TWIN POND (LOWER)	G241	00019	2092	57	1	08/09/78	8.40	METER		021.00	-	1
5- 295	TWIN POND (UPPER)	G241	00013	2092	57	1	08/09/78	7.30	METER		024.00	-	1
4- 185	TWIN PONDS	F202	00026	1950	22	5	03/11/75	4.70	UNKN	140	.	-	1
4- 584	TWITCHELL LAKE	F214	00134	2050	22	5	02/14/79	4.70	EQ.M	140	027.14	-	1
2- 74	UNION FALLS FLOW	C254	01376	1407	10	4	08/20/79	6.56	EQ.M	336	65.70	6.59	1
5- 658	UNKNOWN POND	F233	00038	1630	21	1	07/24/79	6.30	EQ.M	214	52.30	6.02	1
4- 140	UNNAMED	E192	00010	0200	25	4	07/20/76	6.50	UNKN	980	.	-	1
4- 205	UNNAMED	F211	00016	2045	22	5	07/24/75	4.61	UNKN		023.10	-	1
4- 208	UNNAMED	F211	00008	2050	22	5	07/21/77	4.40	METER		.	-	1
4- 518	UNNAMED	F211	00015	1760	22	5	06/15/76	4.60	UNKN	320	.	-	1
4- 566	UNNAMED	F212	00008	1090	21	5	08/23/79	4.20	EQ.M	30	30.50	-	1
6- 323	UNNAMED POND	F224	17	2045	21	6	06/24/75	5.42	METER	12	26.27	-	1
7- 960	UNNAMED POND	H221	00001	2100	21	5	06/24/75	4.70		-11	025.06	-	1
2- 277	UPPER AUSAPLE LAKE	E253	00134	1991	16	1	08/22/79	5.94	EQ.M	75	29.20	3.47	1
2- 271	UPPER CASCADE LAKE	E251	26	2035	16	3	06/24/75	7.15	METER	169	60.93	5.20	2
6- 328	UPPER CHAIN POND	F213	3	2065	21	5	06/24/75	4.54	METER	-29	29.57	-	1
3- 68	UPPER CHATEAUGAY LAKE	B243	02605	1309	10	2	07/23/76	7.00	COLOR		.	-	1
5- 602	UPPER DUG MOUNTAIN POND	G233	00013	1795	21	1	08/29/79	5.72	EQ.M	43	29.00	-	1
2- 347	UPPER FEEDER POND	E263	00013	1450	16	4	08/22/79	5.89	EQ.M	49	30.20	3.75	1
5- 255	UPPER LOOMIS POND	H234	00032	2267	21	5	06/24/75	4.72	METER	011	028.05	1.50	2
4- 491	UPPER MOSHIER POND	F202	00045	1661	22	5	07/28/75	4.92	UNKN		001.60	-	1
5- 306	UPPER PINE LAKE	G233	6	2030	21	1	06/24/75	6.33	METER	120	030.52	-	1
6- 239	UPPER PRESTON POND	E242	64	2155	16	1	06/24/75	5.17	METER	-3	26.25	2.44	2
2- 114	UPPER SARANAC	D233	05056	1573	17	2	07/22/76	6.85	METER		.	-	1
6- 296	UPPER SARGENT POND	F223	00134	1824	21	4	08/28/79	6.06	EQ.M	72	33.00	3.47	1
4- 769	UPPER SISTER LAKE	F212	00083	1930	21	5	08/23/79	4.17	EQ.M	-50	25.40	1.77	1
4- 200	UPPER SOUTH POND	F202	00019	1990	22	5	03/11/75	4.70	UNKN	140	.	-	1
2- 409	UPPER SPECTACLE POND	G263	13	1650	58	1	08/30/79	5.81	EQ.M	7	32.10	-	1

KEY CHEMISTRY INFORMATION FOR ADIRONDACK PONDED WATERS

W'SHED S F#	NAME OF WATER	7.5' QUAD	SURF AREA	SURF ELEV	CNTY	ADK ZONE	DATE PH	SURF PH	PH MTH	ALKAL UEQ/L	SURF COND	CA MG/L	DATA SOURCE
3- 265	UPPER ST REGIS LAKE	D232	00817	1619	17	2	06/21/79	6.47	EQ.M	146	38.50	3.73	1
4- 219	UPPER TWIN POND	F201	00017	1352	25	1	07/22/76	5.40	UNKN	280	.	-	1
5- 719	UPPER WALLFACE POND	E242	17	3110	16	6	07/18/78	5.00	METER	5	19.40	-	3
6- 304	UTOWANA LAKE	F223	00320	1789	21	4	06/28/79	6.14	EQ.M	88	39.50	3.71	1
5- 370	VALENTINE POND	C252	00102	0821	57	4	08/30/79	7.31	EQ.M	526	84.20	12.57	1
7- 689	VANDENBURG POND	1233	00141	1490	18	4	08/31/79	5.90	EQ.M	39	27.90	2.81	1
5- 554	VANDERWACKER POND	E242	00026	1970	16	1	07/20/78	6.10	UNKN		025.00	-	1
5- 666	WAKELY POND	E231	39	2093	21	1	06/24/75	6.55	METER	081	026.43	3.00	2
4- 214	WALKER POND	F211	39	2086	22	5	06/24/75	4.68	METER	-12	029.29	1.80	2
4- 346	WASHBOWL	E214	8	1690	22	5	08/29/78	4.48	METER	-46		-	3
2- 209	WELLER POND	D233	00179	1536	17	4	07/07/75	6.80	COLOR		.	-	1
7- 698	WEST CAROGA LAKE	1231	00314	1455	18	3	08/31/79	6.19	EQ.M	121	59.60	4.30	1
4- 749	WEST LAKE	F213	00027	1819	22	1	08/27/79	6.21	EQ.M	169	36.60	-	1
7- 931	WEST LAKE (WEST CANADA LAKE)	G224	262	2368	21	1	06/24/75	5.53	METER	002	022.47	1.70	2
4- 364	WEST POND	E214	6	1850	22	5	07/28/76	4.70	UNKN		.	-	1
4- 562	WEST POND	F221	00064	1902	21	6	08/28/79	5.67	EQ.M	32	27.30	2.44	1
4- 656A	WHETSTONE MARSH POND	G192	00100	1900	25	4	06/03/75	7.00	UNKN		.	-	1
2- 180	WHEY POND	D234	00102	1577	17	1	08/21/79	6.63	EQ.M	272	40.90	4.43	1
2- 158	WHIPPLE POND	D234	00006	1620	17	5	03/01/76	4.00	METER		.	-	1
3- 152	WHIPPLE POND	D233	00006	1618	17	6	09/09/76	5.16			.	-	1
5- 603	WHITAKER LAKE	G233	00154	1765	21	4	08/29/79	6.07	EQ.M	104	30.60	3.36	1
7- 865	WHITE BIRCH LAKE	H222	00006	2470	21	5	06/24/75	4.92	METER	-08	026.13	0.96	2
4- 958	WHITE LAKE	G204	00237	1422	33	2	08/27/79	6.54	EQ.M	118	58.80	4.98	1
5- 566	WHITE LILY POND	E253	19	2112	16	1	06/24/75	6.70	METER	117	35.14	3.82	2
7- 936	WHITNEY LAKE	G223	00115	2456	21	5	07/11/77	4.70	UNKN		.		
6- 35	WHITNEY POND	D221	6	1516	45	4	08/21/79	6.02	EQ.M	98	36.70	-	1
5- 411	WHORTLEBERRY POND	F264	00058	1103	16	1	08/30/79	6.71	EQ.M	229	51.40	6.87	1
5- 568	WHORTLEBERRY POND	F244	00019	1670	21	3	08/20/79	6.57	EQ.M	132	39.10	5.37	1
5- 168	WILCOX LAKE	H241	141	1445	57	1	08/29/79	5.95	EQ.M	40	28.70	2.90	1
5- 215	WILLIS LAKE	H244	00032	1304	21	4	08/29/79	5.81	EQ.M	33	26.00	2.82	1
7- 950	WILMURT LAKE	H221	00109	2467	21	6	06/24/75	6.75	METER	072	029.01	3.84	2
5- 653	WILSON POND	F234	6	2150	21	1	06/24/75	6.33	METER	058	027.85	2.44	2
2- 236	WINCH POND	D254	00004	1860	16	1	11/09/79	6.24	EQ.M	139	54.50	6.55	1
4- 727	WINDFALL POND	G202	00032	1692	22	6	07/31/75	6.56	UNKN		032.00	-	1
5- 529A	WINDOVER LAKE OR ROSS LAKE	G243	00089	1500	57	4	08/29/79	7.00	EQ.M	368	62.20	6.66	1
4- 528	WITCHHOPPLE LAKE	F211	00134	1745	22	5	06/29/76	4.91	UNKN	020	.	-	1
4- 873	WOLF LAKE	G221	17	2600	21	5	06/24/75	4.39	METER	-16	34.00	1.24	2
3- 65	WOLF POND	C242	00051	1512	17	5	08/20/79	3.99	EQ.M	-69	18.50	1.01	1
3- 177	WOLF POND	C233	00026	1609	17	1	08/21/79	5.56	EQ.M	20	27.00	2.40	
4- 248	WOLF POND	B193	00032	0797	45	4	07/17/76	6.20	COLOR	140	.	-	1
4- 352	WOLF POND	F214	00070	1775	22	5	08/27/79	4.22	EQ.M	-52	25.90	1.64	1
5- 561	WOLF POND	F251	00067	1828	16	1	06/30/79	6.37	EQ.M	154	41.60	5.67	1
5- 640	WOLF POND	F232	38	2367	21	1	06/24/75	6.05	METER	014	024.80	2.44	2
5- 688	WOLF POND	E244	156	1623	16	1	07/24/78	7.27	METER	60	30.50	-	3
4- 982	WOODHULL LAKE	G214	1158	1675	22	2	08/09/78	5.71	METER	13	.	-	1
5- 681	WOODRUFF POND	F241	00051	1555	16	4	08/29/79	6.86	EQ.M	278	55.00	6.79	1
4- 576	WOODS LAKE	F214	00064	1990	22	1	06/18/76	5.80	UNKN		.	-	1
5- 1548	WOODWARD LAKE	I241	00096	0790	18	4	08/31/79	7.02	EQ.M	294	53.30	5.72	1
2- 184	12TH TEE POND	D233	00005	1620	17	5	05/09/78	4.35	METER		.		

849 TOTAL NUMBER RECORDS

APPENDIX II

Procedures for determination of pH, alkalinity and conductivity (from Schofield 1978)

1. Equilibrate samples to ambient laboratory room temperature. Measure and record this temperature to the nearest °C for each set of samples analyzed.
2. Shake sample bottle to mix, open cap, and insert dip cell of conductivity meter (previously stored and rinsed in distilled water). Measure conductivity in umhos and if cell is not temperature compensated, correct reading if necessary to 25°C (Table 3.1, pg. 20 ref. (5)). Record the conductivity in umhos at 25°C.
3. Pipette 50.0 ml (volumetric pipette) of sample into a titration vessel of 200 ml capacity (we use 250 ml plastic sample bottles with the tops cut off). All pipettes and titration vessels should be rinsed in distilled water between each sample analysis.
4. Insert distilled-water-rinsed pH electrodes and gas dispersion tube into sample in titration vessel. Aerate the sample vigorously with air from an aquarium type pump (no oil contamination) through the gas dispersion tube.
5. Set sample temperature on pH meter compensator and monitor pH as sample aerates. Record the air equilibrium pH value of the sample.
6. Maintaining continous aeration, titrate the sample in step-wise fashion by adding 20 ul increments of 0.1N HCl from a calibrated piston transfer pipettor with disposable polypropylene tips. The sample is allowed to re-attain pH equilibrium after each increment of acid is added and the pH then recorded. Continue the titration to pH 3.5.
7. Run duplicate titrations for each sample and if the estimated alkalinities differ by more than 10 ueq/liter make a third determination.
8. Before and after each set of samples are analyzed, run duplicate titrations on a standard sodium bicarbonate solution prepared as follows:

a. Pipette 50.0 ml distilled water into titration vessel and add 50 ul 1 N sodium hydroxide.

b. Proceed as for samples from step # 4 above.

9. Calculate total alkalinity for samples and standards as follows:

a. Compute Gran's Plot functions (F_1) for each step in the titration:

$F_1 = 10^{-pH}$ (Vs + Va), where V_s = sample volume in ml and

V_a = cumulative acid volume in ml.

b. Plot F_1 (ordinate) against V_a (abscissa). Draw a straight line only through those points which exhibit a linear relationship (usually those points corresponding to pH values < 4.5). Alternatively, do a least squares regression for the linear set of values to determine the slope and intercept. If the graphic method is employed, the point of intercept of the straight line with the abscissa gives the end-point volume (Ve) of the titration. If a regression analysis is used, then $V_e = \frac{-1 X a}{b}$, where a = regression intercept and b = slope.

c. Compute alkalinity (A in ueq/liter) as:

$A = \frac{Ve X N X 10^6}{Vs}$, where Ve - end point

Volume in ml, N = acid normality, and V_s = sample volume in ml.

APPENDIX III

Case Histories of Selected, Representative Adirondack Ponded Waters Which are Undergoing Acidification

The following Adirondack lakes and ponds were selected by Regional Fisheries Managers as typical examples of waters whose fish populations have either been entirely eliminated or dramatically reduced as a result of acidification. Their case histories were summarized from survey records maintained in regional watershed files. Data gaps involving dates of changes in stocking policies, methods of chemical analyses and incomplete surveys prevent the establishment of a precise chronological sequence of events in many cases. Gill nets were the primary netting gear employed in the surveys and the historic absence of resident small Cyprinid fish species in the records for many lakes may well be related to gear selectivity. Also netting intensity varied from survey to survey prohibiting any quantitative evaluation of population changes. It can be assumed that all original biological survey pHs were obtained with the Hellige color comparitor. This method, as discussed in the text, tends to give somewhat higher results than pH meter determinations especially for the more dilute samples.

Despite these shortcomings, the relationship between deteriorating surface pH values and fish losses is quite evident in the case histories which follow.

Flowed Lands UH P704 (Essex Co.) 38 Acres, el. 2745'
Lake Colden UH P706 (Essex Co.) 38 Acres, el. 2764'
(Shallow, partially dammed impoundments with extensive tributary systems)

Since these adjoining high peaks waters had identical fish management histories, their case discussions can be combined in a single narrative.

These remote waters were not visited by the 1932 Upper Hudson Watershed pond survey unit, but it was reported at that time that they both contained large brook trout and it was recommended that each receive 3,000 brook trout fingerlings annually. It is presumed that the resident Forest Ranger arranged for their transport via pack-cans.

Fortunately, for the sake of historical verification of the quality of the brook trout fishing in that time-frame, Mr. Vincent Engels recently authored a small book entitled "Adirondack Fishing in the 1930's". Excerpts from the book, dealing with the High Peaks ponds, are also contained in a May-June 1978, Volume 32, Number 6, "The Conservationist" magazine article entitled: "At the Sources of the Hudson". This memoir alludes to the excellent angling opportunity for large speckled trout available in both Flowed Lands and Lake Colden and praises the resident Ranger for his vigilance in preventing the introduction of undesirable competitive coarse fish.

By the late 1950s, fishermen were beginning to register complaints regarding the deterioration of brook trout angling in these waters despite an annual aerial stocking program involving 1,900 domestic brook trout fingerlings for each lake. A cursory survey, conducted in June of 1958, revealed a marginal surface pH of 5.4 in both waters and daylight gill net sets only collected one 10-inch brook trout specimen in Lake Colden.

Subsequently, one planting of Honnedaga wild strain brook trout was made in both lakes and overnight gill net sets made in August of 1965 collected 11 specimens from Lake Colden, ranging from 5.6-9.2 inches, and 12 specimens from Flowed Lands, ranging from 5.7-11.7 inches. At this time, their respective surface pH's were 5.0 and 4.9. Commencing in 1966, a split stocking policy of marked domestic and Honnedaga wild strain brook trout was initiated as an experiment in an effort to document the presumed superiority of the wild variety.

In August of 1968, overnight gill net sets collected no fish life in Lake Colden but four specimens from Flowed Lands, ranging from 7.0-9.8 inches. Fin-clips indicated that one was a survivor of the Honnedaga strain planting one represented the domestic planting and two unmarked specimens were presumed to be of wild origin. At this point in time, both waters registered a surface pH of 4.9. Since previous studies indicated that larger fish are more resistant to the stress of acidification, a yearling stocking program was substituted.

A subsequent overnight gill net check conducted in June of 1970 failed to collect any brook trout specimens whatsoever but crayfish were still present in both waters, despite a surface pH of 4.5. Since some former fingerling plantings had yielded modest returns, the stocking policy was changed back to domestic fall fingerlings. A final overnight gill netting effort was made in July of 1973 and again only crayfish were collected. At that point in time, both waters registered a surface pH of 4.9. In view of the negative results obtained, the stocking program was terminated.

A subsequent chemical survey in 1975 by Dr. Carl Schofield of Cornell University revealed meter pH values of 4.77 and 4.84 in Lake Colden and Flowed Lands, respectively. Another independent chemical survey, conducted by Don Charles associated with Indiana University, registered a meter pH of 4.87 for Lake Colden during August 1978.

These vulnerable high elevation waters probably provide the best documentaries of fish population loss among the available case histories due, in large part, to Mr. Engels' published remembrances of their former productivity. It is interesting to note that nearby small, six-acre, Livingston Pond, still supports a population of wild brook trout with a surface pH of 5.1, recorded in the summer of 1978. This body of water received a lime treatment in 1979 to help preserve this vulnerable resource.

South Lake OB P1004 (Herkimer Co.) 499 Acres, el. 2018'
(A deep lake, partially regulated by a 30' man-made dam)

This accessible body of water was not visited by the 1931 Oswegatchie and Black Watershed pond survey unit but the survey report indicated the presence of lake trout, brook trout, whitefish and native minnows. Angling was reported to be good and a lake trout and brook trout fingerling stocking policy was recommended.

In June of 1948, a cursory gill netting effort produced one lake trout specimen and two white suckers. A February 1949 report recommended that brook trout stocking be discontinued and that 22,000 lake trout fingerlings should be stocked annually. A subsequent report, dated 1954, recommended that the former brook trout fingerling policy be reinstated. In August of 1957, a sounding map was produced and although a chemistry check was conducted, no pH readings were taken. Survey gill nets captured nine lake trout specimens, ranging from 12.0-30.5 inches, seven brook trout, ranging from 7.1-9.6 inches, 188 white suckers, eight brown bullheads and five lake chubs.

A subsequent gill net collection, conducted in August 1961, captured 68 immature lake trout, ranging from 10-14 inches, four brook trout, ranging from 7.5-12.0 inches, 25 white suckers, one brown bullhead and one lake chub. Due to obvious growth stagnation among lake trout, stocking of this species was temporarily discontinued. In July of 1964, another gill netting survey accounted for 62 lake trout, ranging from 6-21 inches, nine brown bullheads, eight white suckers and five lake chubs.

The stocking policy was revised in March of 1966 and the new policy called for 8,000 domestic brook trout fingerlings along with 2,000 Assinica wild strain brook trout fingerlings which were to be fin-clipped. A subsequent December 1966 stocking policy called for 7,000 domestic brook trout fingerlings and 3,000 Assinica x Domestic hybrid brook trout yearlings which were also to be distinctively fin-clipped. In May of 1968, a gill net check collected six brook trout specimens, ranging from 8.5-16.7 inches, four lake trout, ranging from 15.1-18.6 inches, 30 white suckers and 10 brown bullheads. One brook trout was clipped.

A May 1968 chemistry check indicated a surface pH of 5.3. Subsequently, a July 1968 chemistry check revealed a surface pH of 4.6. In November of 1968, a new stocking policy recommended 7,000 Honnedaga wild strain brook trout fingerlings. Gill netting conducted in June 1973 failed to produce any lake trout specimens but collected seven brook trout, ranging from 6-13 inches, 10 white suckers and three lake chubs. A new stocking policy was initiated in July of 1973 and this called for 7,000 domestic brook trout fingerlings and 5,000 Adirondack strain lake trout fingerlings. The stocking policy was slightly revised in January 1974 when an additional 3,500 brook trout yearlings were recommended for that year only.

A pH reading of 5.7 was documented in a March 1975 chemistry check. In January of 1977, the stocking policy was again changed to 2,100 Adirondack strain lake trout yearlings and brook trout stocking was discontinued. Dr. Carl Schofield sampled the lake in June 1975 and obtained a laboratory meter equilibrium pH reading of 4.98. A subsequent chemistry check, conducted in August of 1978, revealed a "Hach" kit colorimetric pH of 5.7, but a Lab-meter reading indicated a pH of 4.87. The final gill netting effort of June 1978 produced absolutely no game fish as only 10 lake chubs were collected. As a result, all stocking was discontinued and the lake was declared chemically unsuitable. A series of laboratory meter equilibrium pH measurements, conducted during the summer of 1979, gave readings ranging from 5.13 to 5.31.

The case history of South Lake illustrates a rather rapid decline in fish species diversity and abundance during the past decade, despite a variety of stocking programs involving domestic, wild strain and hybrid brook trout and lake trout. This water represents one of six lakes which have been selected as monitoring waters candidates and is scheduled for routine water chemistry sampling every summer and winter and will be test-netted at three-year intervals.

Metcalf Lake MH P897 (Hamilton Co.) 64 Acres, el. 2379'

The July 1934 original biological survey documented a colorimetric surface pH of 7.6 and reported an abundance of brook trout, including young-of-year specimens presumed to represent natural reproductions. An annual stocking policy of 10,000 fall fingerlings was recommended. This was subsequently reduced to 5,000 and an August 1956 gill netting effort recorded a 10-foot depth pH reading of 6.6 and collected 10 brook trout specimens, ranging from 9.0-11.2 inches. In August of 1972, stocking was discontinued to determine if natural reproduction would sustain the brook trout population. A September 1973 Schofield laboratory meter pH reading of 5.0 was documented at that time. In August 1975 a gill net check failed to produce any fish specimens and another Schofield laboratory meter pH reading of 4.92 was recorded. In view of these negative results, all stocking was terminated in 1976.

The case history of Metcalf Lake illustrates the extirpation of a brook trout population in a body of water which sustained natural reproduction of that species in the days of the original survey.

Silver Lake UH P270 (Hamilton Co.) 64 Acres, el. 2072'

The July 1932 original biological survey documented a colorimetric surface pH of 6.6 and reported good brook trout fishing despite heavy angling pressure. Golden shiners and brown bullheads were also recorded as being present and an annual stocking policy of 7,000 brook trout fingerlings was recommended. Despite annual aerial stocking, a May 1969 gill netting effort failed to collect any fish life and brook trout plantings were terminated. A subsequent Schofield laboratory meter pH reading of 4.92 was recorded in June of 1975 and a final netting effort in August of 1976 also failed to produce a single fish specimen.

The case history of Silver Lake again illustrates the demise of resident brook trout and other native fish populations.

Spruce Lake MH P908 (Hamilton Co.) 179 Acres, el. 2378'

(Part of a remote headwater pond system)

The 1934 original Mohawk-Hudson Watershed pond survey unit did not conduct any netting at Spruce Lake but based on interviews with local anglers, reported the presence of brook trout, lake trout, white suckers, creek chubs, golden shiners and blacknose dace. Fishing pressure was reported to be heavy and a combined stocking policy of 12,000 lake trout and 12,000 brook trout fingerlings was recommended. Chemical analysis revealed a summer surface pH of 7.2. A July 1956 gill netting check collected 38 brook trout specimens, ranging from 5.5 to 15.2 inches, along with white suckers and creek chubs. At this point in time, the surface pH was 6.2. In September 1961, the lake trout stocking policy was discontinued and 10,000 brook trout fingerlings were to be planted by airplane on an annual basis.

A subsequent gill net check, conducted on July 7, 1966, captured 13 brook trout, ranging from 6.2-11.1 inches, along with numerous white suckers. The stocking policy was reduced to 5,000 brook trout fingerlings, in hopes of enhancing growth rates. In June of 1975, Dr. Carl Schofield documented a laboratory meter equilibrium pH reading of 5.02. An August 1976 gill netting effort collected 57 brook trout specimens, ranging from 7.6-16.7 inches, along with two lake trout specimens, ranging from 22.1-23.6 inches, and 16 white suckers and one golden shiner. A field meter pH reading of 4.7 was recorded in August of 1978. Winter chemistry, conducted in February 1979, yielded a laboratory meter equilibrium pH of 5.05. Brook trout fingerling stocking was converted from domestic strain to Temiscamie x Domestic hybrids in the fall of 1977.

In July of 1979, a gill netting check accounted for 82 brook trout specimens ranging from 6-17.6 inches. The youngest age group was well represented. No other fish life but brook trout was collected or observed. At this time a field surface pH of 4.2 was recorded but a laboratory meter equilibrium pH of 5.06 appears to be more reasonable in light of the good survival of brook trout.

This case history points out the possible superiority of the Temiscamie x Domestic hybrids and their backcrosses in connection with Adirondack brook trout stocking programs for ponded waters which are threatened with acidification.

Recent research has indicated that this hybrid is quite acid-tolerant.

Big Moose Lake OB P752 (Herkimer Co.) 1,268 Acres, el. 1825'

(A large, relatively deep body of water having an extensive
tributary system, with considerable shoreline development)

The 1931 Oswegatchie and Black Watershed pond survey report indicated the presence of good self-maintaining lake trout, brook trout, whitefish and smallmouth bass populations, but sporadic stocking was also recommended. No water chemistry was conducted at that time and the first surface pH reading on record, was obtained in September of 1948 in connection with a gill netting survey.

In conjunction with a pH of 6.0, the test gill nets disclosed the presence of an abundant yellow perch population. Brown bullheads, white suckers, brook trout, lake trout and killifish were listed as being common, while longnose suckers and whitefish were listed as being fairly common. No smallmouth bass were collected or observed.

Big Moose Lake received a variety of marked and unmarked plantings of various sizes and species of fish through the years, including: lake trout, brook trout, rainbow trout, splake, smallmouth bass, largemouth bass and alewives. Annual test nettings, employing both gill nets and trap nets, took place during the 1950s and 1960s along with periodic chemistry checks.

During the early 1950s, there was a concerted effort to exercise yellow perch control by dislodging their egg masses but this proved to be ineffectual. Marked lake trout plantings yielded modest survival but growth rates were severely depressed and relatively few lake trout ever attained legal size. Yearling brook trout made some direct contribution, but no really large specimens were ever documented. Attempts at reestablishing black bass and alewives also met with failure. A split brook trout yearling and splake yearling stocking policy was initiated in the spring of 1965.

An August 1965 chemical survey revealed a surface pH reading of 5.2 and a June 1971 reading was 5.5 while the latest 1979 survey surface sample meter reading was 4.17. Sporadic gill net checks in the 1970s indicated a marked decline in fish population abundance with very few desirable coldwater game fish present. As a result, all stocking policies were terminated on December 7, 1975. Intensive gill netting disclosed that some pan and coarse fishes, such as brown bullhead, yellow perch, white suckers and golden shiners, were still present during this time frame but only a very limited number of pumpkinseed sunfish and a single creek chub were recovered. Also, most of the white suckers were fairly large with only one specimen under 10 inches being represented in the sampling.

Canada Lake MH P717 (Fulton Co.) 525 Acres, el. 1550'

(A deep, relatively infertile body of water with considerable shoreline development and a fall water level drawdown regime)

The 1934 Mohawk-Hudson Watershed pond survey report indicated that Canada Lake possessed a reputation for only mediocre angling success despite the presence of a variety of both warm and coldwater fish species and a diversified stocking history. The latter involved fry and/or fingerling plantings of smallmouth bass, lake trout, yellow perch, walleye and whitefish. At that point in time, gill netting, seining and visual observation disclosed the existence of an abundant yellow perch population while brown bullheads and smallmouth bass were rated as being common, chain pickerel and white suckers were rated as being fairly common and lake trout, lake whitefish, golden shiners and fallfish were rated as being rare. A July 1934 colorimetric surface pH reading of 7.2 was documented. It was recommended that lake trout and lake whitefish stocking programs be continued and that either alewives or a plankton feeding minnow species be introduced to provide additional forage. The remaining resident fish species were to be maintained by natural reproduction until food conditions improved.

A subsequent survey, conducted in early September of 1947, documented a surface pH of 6.2. Gill netting and seining efforts accounted for roughly the previous array of fish species present, with the exception of lake trout and lake whitefish, but also disclosed the addition of pumpkinseed sunfish and lake chubsucker. An annual stocking policy of 5,000 lake trout yearlings was recommended at this time. Growth rates for smallmouth bass were considered excellent and since many "young of year" specimens of this species were observed, natural reproduction was considered adequate. In March of 1949, a surface pH of 6.2 was recorded under the ice cover.

Deepwater gill netting, conducted in July of 1952, again disclosed the presence of lake trout along with one lake whitefish. Rock bass and black crappie were first reported present in 1957. The watershed file recorded a July 1958 chemistry check intended to correlate lack of success associated with a 1958 rainbow trout yearling stocking effort. A methyl-orange surface sample alkalinity reading of 6.0 ppm was documented but there was no notation of corresponding pH. A subsequent intensive gill netting check was conducted in October of 1960. This accounted for modest numbers of both lake trout and lake whitefish along with smallmouth bass, white suckers and one lake chubsucker. In the spring of 1961, an experimental rainbow trout yearling stocking was recommended for that year only. While the lake trout yearling stocking policy remained in effect throughout, subsequent years saw sporadic plantings of a variety of salmonids, including: brook trout fingerlings (1964-1965), splake yearlings (1965-1969, 1972) and red salmon fry (1968-1972). In 1974, 1975 and 1976, smelt egg transfers were attempted in an effort to establish a deepwater forage fish.

Despite a considerable number of fish collection attempts, no rainbow trout, brook trout, red salmon or smelt were ever recovered and only two small splake specimens were collected in a September 1968 gill netting effort. Since the frequent test netting results occupy many pages, we will attempt to condense the findings in a few short paragraphs. Lake whitefish were last recorded in 1968 while smallmouth bass were last reported in 1969 as subsequent netting attempts failed to document their continued presence. Angler reports also substantiate this species disappearance. Only one large white sucker specimen was collected in the intensive 1976 survey and panfish populations of pumpkinseed sunfish, black crappie and rock bass were found to be at very low densities. A chronological record of corresponding pH determinations follows: June 1964-6.8; September 1975 (field colorimetric)-7.0, (meter)-5.85; July 1976 (meter, three surface stations)-5.80, 5.97, 5.81; August 1979 (meter)-5.2). In 1976, the lake trout yearling stocking policy was reduced to 2,600 in keeping with new guidelines for lake trout stocking. An experimental brown trout stocking policy, involving 2,600 yearlings, was also initiated in 1979, in hopes that this species might demonstrate greater acid tolerance.

The case history of Canada Lake demonstrates the extirpation of smallmouth bass and lake whitefish populations, presumed to be related to reproductive failure in response to declining pH values. A marked reduction in the white sucker population is also presumed to be related to acidification as is the failure of various stocking programs.

Twitchell Lake, OB P584 (Herkimer Co.) 140 Acres, el. 2050'

(A relatively shallow lake with one major inlet and several smaller ones)

The 1931 Oswegatchie and Black Watershed pond survey unit recorded a summer surface pH of 6.6 and assigned an annual stocking policy of 7,000 brook trout fingerlings. Sometime between 1931 and 1954, yellow perch were introduced and brook trout stocking was discontinued. A July 1954 chemical survey disclosed a suspicious 10-foot depth pH reading of 4.9 and a 20-foot depth reading of 5.1.

A successful reclamation effort, conducted in September 1955, eliminated the competitive yellow perch population as evidenced by a 1957 test gill net check which recovered only stocked brook trout and no other fish species. In the ensuing years, this body of water received a great variety of marked and unmarked plantings of various strains and sizes of brook trout, including: Domestic fingerlings and yearlings, Horn Lake strain fingerlings, Honnedaga Lake strain fingerlings, Rome Laboratory strain fingerlings, Horn, Honnedaga and Domestic mixtures of eggs, Horn Lake x Domestic hybrids and Honnedaga x Domestic hybrids.

In an effort to check on the contribution of these experimental plantings, Twitchell Lake was test netted on almost an annual basis and periodic chemical surveys were also conducted at intervals. Initial survival of the stocked plantings was generally excellent and a successful brook trout fishery was developed although no trophy-size fish were ever produced. A single brown bullhead specimen was captured in 1959 and by 1971 this species was abundant. The increase in the bullhead population was accompanied by a marked decline in the abundance of brook trout.

A July 1968 chemical survey disclosed a surface pH reading of 5.4 while a 1969 winter chemistry check indicated a pH of 4.3. A subsequent chemistry check in June of 1971 revealed a surface pH of 5.0 as did a winter reading in 1974 (laboratory equilibrium meter pH reading was 4.96). The most recent chemistry data relates to a winter 1979 reading of 4.7. At this point in time, Twitchell Lake is still receiving an annual stocking policy of 5,500 brook trout yearlings, but survival appears to be extremely low. Brown bullheads still appear to be relatively abundant.

Consideration is being given to an experimental liming program in hopes of improving brook trout survival in this scenic, accessible water. It is also speculated that a switch to more acid-tolerant Temiscamie x Domestic hybrids might help enhance trout survival.

Honnedaga Lake MH P877 (Herkimer Co.) 838 Acres, el. 2189'

(A large, deep headwater lake which demonstrates bizarre unfavorable conditions for fish survival)

The following historical background material was gleaned from scattered Adirondack League Club fish management reports dating from 1953. Honnedaga Lake originally contained only native brook trout and offered superlative angling for this species in its pristine state. A variety of introduced fishes became well established in the late 1800s but subsequently disappeared from the scene. Thus, suckers, round whitefish, dace and smelt were extirpated by the 1920s while lake trout persisted to the 1930s, with only brook trout remaining following the demise of the introduced varieties.

League Club reports allude to a stocking program involving 10,000 brook trout fingerlings, undertaken on the 1950-1953 time-frame, along with a recommendation to stock 20,000 advanced fry in 1954. In 1956, the annual report commented on a heavy mortality of hatchery fish. The year 1957 saw the commencement of a program designed to enhance natural spawning through the addition of washed gravel, placed in boxes with piped inflowing water, at tributary mouths. A planting of 5,400 Honnedaga strain brook trout fingerlings was made in 1958 and live cage tests with hatchery fish indicated lethal conditions for certain lots of fish which had not been previously acclimated at the Cornell Fish Hatchery at Ithaca. Subsequent chemical research in 1959, by Dr. Carl Schofield, indicated lethal concentrations of zinc and manganese. The survival of hatchery fish, previously conditioned in Cornell Hatchery water, was proven to be related to the relatively high zinc content of that water supply.

Ongoing research continued through the years and demonstrated superior survival of the native Honnedaga strain of brook trout under these adverse chemical conditions as well as the success of the spawning boxes in promoting natural reproduction. However, the year 1967 again marked the observance of dead trout and trap net catches of brook trout diminished markedly in the ensuing years. An August 1979 surface meter pH reading of 5.75 was considered abnormally high due to a lack of precipitation in that year since a late June of 1975 surface meter pH of 4.91 had been recorded previously.

The case history of Honnedaga Lake is unique in that it documents the mobilization of toxic metals, such as zinc, under increasingly acidified conditions. It also points out the relative tolerance of the acclimated, native, heritage strain of brook trout. With ongoing acid precipitation, even this genetic tolerance does not appear to be able to sustain the population and it has reportedly declined to only token numbers.

Brook Trout Lake OB P874 (Hamilton Co.) 77 Acres, el. 2369'
(A remote headwater pond)

This remote body of water was not checked by the Oswegatchie and Black Watershed survey crew in 1931. However, a May 1936 report indicates good angling success for brook trout and recommended an annual stocking policy of 1,500 fingerlings, but this was rarely fulfilled due to its remote location.

In August of 1950, a gill net and angling effort collected 45 presumed wild brook trout specimens, ranging from 6.5-14.7 inches and documented a colorimetric pH of 6.0. An annual aerial brook trout stocking program was initiated in the fall of 1956 when the lake received 1,500 fall fingerlings of domestic origin. A subsequent gill net collection in August 1963 produced 3 brook trout, ranging from 6.5-15.8 inches. Only six brook trout were collected in an August 1969 gill netting effort and these ranged from 6.4-13.1 inches. Brook trout stocking was discontinued in August 1972 in hopes of promoting natural reproduction.

Dr. Carl Schofield documented a laboratory surface equilibrium meter pH of 4.99 in June of 1975 and gill netting in August of that year produced only two brook trout of 9.6 and 14 inches.

This case history illustrates a marked brook trout population decline which logically reflects minimal natural reproduction in the face of growing acidification. Due to the very marginal 1975 pH determination and the remote location of this body of water, there are no plans to resume trout stocking.

Horn Lake OB P854 (Herkimer Co.) 38 Acres, el. 2301'
(A remote high elevation, headwater pond, containing
no other fish life but native brook trout)

The 1931 Oswegatchie and Black Watershed pond survey units did not study this body of water due to its private posted status, in connection with a paper company lease to the Adirondack League Club. Scattered League Club fishery management reports, dating from 1953 onward, provide us with some background information prior to state acquisition of this property in the early 1960s. Despite the fact that Horn Lake historically contained adequate stocks of native Adirondack heritage strain brook trout, which were maintained by natural reproduction, a private stocking was documented for 1946. A private fishery survey of League Club waters, conducted in September of 1953, revealed a 10-foot depth sample pH of 5.5 and test gill nets accounted for 32 brook trout specimens, ranging from 9.1-13.4 inches. In 1958, Horn Lake produced the greatest brook trout catch ever recorded in League Club records, when 301 specimens were harvested by anglers.

The following year there was an unsuccessful attempt to secure brook trout eggs. Subsequently in 1960, adult fish were transferred to Little Moose Lake Fish Hatchery for ripening which resulted in a successful egg take. Angling success was reported as poor in 1961 and no egg collection effort was made in 1963. A planting of 500 marked Horn Lake wild strain brook trout fingerlings was made in September 1964. In November of 1965, a fall trap netting effort collected 58 brook trout specimens, ranging from 8.5-15.2 inches. Since most of the adult females were not ripe, mature fish were transported to Brandon Park for subsequent stripping. These eventually yielded 27,000± eggs.

In 1966, a similar fall trap netting operation collected 108 brook trout, ranging from 8.8-14.0 inches, but due to a paucity of ripe females, only 5,400 eggs were taken. On this occasion, a surface pH of 6.3 was recorded. In September of 1968, Horn Lake received a planting of 711 marked Horn Lake strain fish and in November of that year it was recommended that a 14-inch trophy size limit be established to protect future spawners. A daylight gill net set netted 24 Horn Lake brook trout specimens ranging from 8-14 inches and the males were taken to Rome Hatchery for sperm collections in an effort to create hybrids. The years 1970 and 1971 saw additional marked plantings of Horn Lake strain fingerlings.

Concern for IPN disease prompted a special daylight gill net collection in October 1971. Fortunately, the tests on 22 fish, averaging nine inches, turned out to be negative but increasing concern regarding the preservation of this heritage strain prompted closure of the lake to all fishing. In 1972, contour mapping and a chemistry check were undertaken and a surface pH of 6.0 was recorded. A daylight gill net check, conducted in June 1974, yielded seven brook trout specimens, ranging from 11.5-14.8 inches, with an accompanying surface pH reading of 6.0. This was apparently an abnormally high colorimetric determination because a contemporary Schofield meter reading indicated a much lower surface pH of 4.94.

Horn Lake strain fish were transferred to their heritage water from Long Pond in Franklin County which had previously been stocked with this pure strain. A July 1975 overnight gill net set obtained 39 brook trout specimens, ranging from 8.1-15.1 inches, but almost all of these fish were fin-clipped indicating that natural spawning was now minimal. These results prompted a hydrated lime treatment which produced a post-treatment meter pH of 5.96.

In July 1977, overnight and daylight gill net sets for mercury analysis revealed that a strong year class had been produced after the initial liming and the nets yielded 32 brook trout specimens, ranging from 8.5-17.2 inches. Both marked and unmarked (wild) fish were collected in this sample. In October 1978, an agricultural lime treatment, involving 20 tons, was made via helicopter bucket, at a cost of almost $4,000. A subsequent winter chemistry check indicated a surface pH of 5.0. In July of 1979, a final daylight gill netting produced only two age III+ brook trout. The absence of small, young fish indicated that natural spawning was insignificant although a pH reading of 6.2 was obtained at this time. The pH readings suggest that water quality improvements effected by the October 1978 lime treatment occurred too slowly to protect the 1978 fall fingerling plantings.

The case history of Horn Lake again demonstrates that even native, wild strain brook trout are subject to reproductive failure in acid impacted, Adirondack waters.

Cranberry Lake OB P309 (St. Lawrence Co.) 6,976 Acres, el. 1,486'

(A large flowage of the Oswegatchie River, which submerged a smaller permanent natural lake with an extensive tributary system)

In 1867, Cranberry Lake Reservoir was created with the completion of a man-made dam at its outlet for purposes of providing water for the transportation of logs down its outlet, the Oswegatchie River. This remote, inaccessible area became famous for its virgin brook trout fishing around 1875. By 1915, local chronicles attested to the greatly increased angling pressure with a resulting diminution of quality brook trout fishing. A Roosevelt Wildlife Station fisheries survey was conducted between 1923 and 1925 which, in addition to brook trout, also documented the presence of brown bullheads, white suckers, longnose suckers, northern redbelly dace, creek chub, common shiner, blacknose dace, lake chub, pumpkinseed sunfish and sculpin.

The 1931 biological survey of the Oswegatchie and Black Watershed pond survey report commented on the continued presence of large brook trout despite local claims of poor angling success. It was also pointed out that heavy beaver activity on the inlet stream destroyed trout spawning beds. In addition to the fish species reported by the Roosevelt Wildlife Station survey, brassy, minnows, pearl dace and golden shiners were also documented. There were also comments alluding to the previous unsuccessful plantings of lake trout and lake whitefish and a report on the rare presence of brown trout. A surface colorimetric pH reading of 6.7 was recorded at this time.

Starting in 1921, Cranberry Lake and its tributaries received assorted plantings of brook trout of various sizes but this policy was discontinued in 1952 following a yellow perch explosion. This exotic warmwater species was first observed in 1948 at the start of a four-year creel census program which documented the collapse of brook trout fishing in the face of yellow perch competition and beaver damage to the tributary system. It is probable that the more subtle long-term negative influences of lumbering and forest fires also damaged the watershed to the eventual detriment of brook trout reproduction. Rainbow trout yearling stocking was initiated in 1952. This was followed by sporadic plantings of Atlantic salmon and brown trout and test netting in 1959 also disclosed the new establishment of rock bass.

The presence of smallmouth bass adults was noted prior to 1960 and, in that year, a decision was made to commence purposeful plantings of bass fry. Within a few seasons, smallmouth "young-of-year" were widely distributed indicating successful natural reproduction of the adult bass which were present prior to the stocking program. However, on August 10, 1961 a few days previous to stocking, a massive mortality of smallmouth bass fingerlings was noted along shore. Commencing in 1963, an alternate fingerling-yearling splake stocking policy was initiated. Since subsequent netting efforts failed to recapture any splake specimens, this program was discontinued in 1969 when all game fish stocking was terminated. A 1966 gill netting documented the first and last report of rainbow smelt.

During the intervening years, the smallmouth bass population continued to thrive and expand and some of the older specimens attained a very desirable size, in excess of four pounds. Beginning in 1969 to the present, purposeful fish collections were made for mercury analysis and the older bass were found to exceed recommended levels. By 1978, there was a visible decline in the net catch of both smallmouth bass and yellow perch which indicated a marked population decline in the face of growing acidification. An August 1979 meter pH reading of 5.56 was recorded. The July 1979 gill netting effort also accounted for five brook trout specimens. This netting result represents the first time in twenty years that brook trout were captured in the lake and reflects this species relative acid tolerance. Anecdotal evidence from local anglers also indicates that brook trout have been reappearing in lake springholes in the recent past.

The case history of Cranberry Lake illustrates the collapse of a brook trout fishery following a yellow perch population explosion and the failure of stocking programs involving a variety of other salmonids. It also indicates the very successful early establishment of a smallmouth bass population which subsequently demonstrated excessive levels of mercury contamination among older-aged fish. Recent netting results have also indicated a sharp reduction in the resident bass and perch populations which possibly reflects reproduction failure associated with growing acidification. At the same time there has been an increase in the native brook trout population in response to reduced competition. This interesting development obviously merits continued investigation and may justify a resumption of experimental brook trout plantings.

Mr. **Barnes**. Thank you, Mr. Chairman. We certainly appreciated your opening remarks and share fully your concern about the acid rain problem as reflected in our statement.

This statement is prepared on behalf of 12 major national environmental groups. All are part of the National Clean Air Coalition, and we have included in our testimony the basic position as adopted so far by the coalition to deal with acid rain.

It is our very firm belief that to further delay taking any steps to abate the problem will only assure irreversible consequences for very many resources, not just lakes, The emerging evidence shows for a wide variety of interests that are of economic importance and also social and recreational importance, including fish of all types, commercial and sport fishing, forest products, agricultural products, and so forth, that there is a lot we don't know yet about the full impact of this phenomenon.

One of the things that characterizes it is a kind of geometric progression. I am sure the chairman is familiar with the nature of a pH scale, but each difference between numbers in the pH scale reflects a tenfold difference, so that two numbers represent a hundredfold difference, and so forth.

What we are finding not just in the United States and Canada, but in Ireland, Northern Europe and Japan, and many places, the pH of rainfall is steadily dropping to levels that are almost unbelievable, in peak storm periods.

Mr. **Scheuer**. The pH level falls, acidity rises, for those who do not understand this.

Mr. **Barnes**. That is right.

Mr. **Scheuer**. Not an arithmetic proportion, but geometric.

Mr. **Barnes**. That is correct. Normal rainfall could be 6.5. If it falls two numbers to 4.5, it has a hundredfold increase in acidity.

In bad storm conditions or peak acid rain readings, occasionally we find acidity at 2.7 to 3.

The soils and bedrock that underlie a lot of the affected regions in the United States and Canada, and also in Northern Europe, don't have the buffering capabilities that some other soils have to neutralize this acid rain, and that is why it appears to most of the scientists who have been seriously studying the problem in the last few years that it may be irreversible.

We might go over a point, and the lake ecosystem, or whatever the ecosystem is, is acidified to the point that basic organisms can't live, and we don't know any way right now to reverse that process.

It seems to us very important to make some political decisions, and I think that is what we have to deal with here. We have to make a political decision that it is valuable for all these various reasons to do two or three things. The first is, we must stop the growth of emissions that cause acid rain.

What is the record of the United States about this in the last couple of years? In both the Carter and now the Reagan administrations, EPA has taken the position that it does not have to look at the impact on other States or in Canada of the relaxation of a State implementation plan or the building of a taller stack on a powerplant than was originally allowed.

All of our scientific understanding that is emerging shows us quite clearly that to relax the standards in Ohio, for example, or

Indiana or Illinois or Michigan does have a negative, a seriously negative impact on other States and on Canada.

In the last couple of years, there have been dozens of these relaxations for utilities in the northern and midwest region.

Mr. **Scheuer**. Relaxations granted by EPA or by the local people?

Mr. **Barnes**. By EPA, with regard to the State limitation plan.

This just goes to show that the Clean Air Act, which has been a very excellent act in many respects, was not designed to cope with acid rain or with these long-range transport phenomena. The various provisions in the act that might be thought to give EPA the authority to deal with the problems have not been so utilized by EPA.

What we need is a clear articulation by the Congress of a goal of stopping the growth of this phenomenon. We need to have a commitment, we feel, over a 10- to 15-year period to spread the cost in an equitable way.

I think in the next month or so the environmental organizations will be coming forth with a suggested plan that we hope will result in the utility cost increases being modest, on the order of maybe 2 percent in the affected areas, to deal with this problem.

There are already some studies on cost in the National Commission on Air Quality report. They analyzed the costs of reducing SO_2 emissions by 7 million tons.

We feel we should try to keep utility cost increases to something that is reasonable and that that should be coupled to a long-term program where we progressively reduce our emissions year by year, using a wide variety of techniques, and I think we shouldn't restrict ourselves here.

Coal washing, for example, offers some very good short-term benefits. To adopt the kind of national plan that was suggested earlier might, however, be an unwise use of capital in terms of other mechanisms, other technological fixes that could reduce the emissions by a great amount more.

These are questions that need to be looked at carefully as to what the proper mix would be.

The base for all this has to be a political decision to reduce the emissions over a period of time and to pay the costs of doing so.

I wanted to say something, in particular, about the research. We think the Federal Government has a very critical role here, both in domestic terms and in terms of meeting international obligations primarily with Canada.

We learned a few days ago that OMB last Tuesday, a week ago Tuesday, rescinded $100 million from EPA's budget and a large percentage of that will be taken out of the R. & D. budget. As a result, virtually all the acid rain research has been frozen. Even the scientists who were supposed to go to Canada this week to meet as a part of the regular consultation set up under our international negotiations with Canada were told they didn't have the travel money to attend the meetings. They did find the money from some other source, but I would think this committee might be very interested in communicating its views to OMB and to EPA about the cuts in this kind of research.

It is like sticking your head in the sand. On one side, the industry says we don't know enough, and then we haven't the capability to find out what are the real problems.

We think this is a very important matter, and if EPA continues to act the way that it seems to have acted in the last week, pushed by OMB, to be sure——

Mr. **Gregg**. Mr. Chairman, may I have a point of clarification here?

Mr. **Scheuer**. Surely.

Mr. **Gregg**. Is it the acid precipitation funds that are frozen?

Mr. **Barnes**. It is unclear. We have tried all week to get exact details, and no one will really tell us what has happened.

A number of scientists involved have received notice to freeze all of their activities, and it includes some of the working group scientists under the memorandum of intent with Canada that have been doing the best work around for the last 6 or 8 months and who play a critical role in developing an agreed-upon plan with Canada for solving this problem.

I haven't the details yet and haven't been able to get them from the Government agencies involved, but there is no doubt it is a significant amount of acid rain funds.

The way it was put to me, Mr. Gregg, was that the unobligated funds of EPA will be frozen, and it is my understanding a very large percentage of the authorized acid rain research funds are technically unobligated for this category.

The other thing I wanted to say, in particular, about the research budget, according to the national acid rain precipitation plan, which is a result of this interagency group working over the last 6 or 8 months, they don't really propose to spend very much money on research or control.

It seems to us that this is a real mistake; that we need to have a very serious commitment of research funds on a priority basis over the next 2 to 5 years to explore these various techniques that could reduce SO_2 and SO_4 and NO_x emissions by 70, 80, or 90 percent.

The one referred to in our testimony has been called Sulf-X, which has been getting some attention in the scientific literature lately. It is a very high order of reduction, if feasible. We don't know the cost on it yet. There are a number of technical solutions which don't involve scrubbers, necessarily, although we continue to believe that scrubbers are a good solution for many situations.

What we would like to see happen is: have the Congress set targets for reductions that are achievable; that are not terribly economically burdensome over a period of 10 or 15 years; that are equitable among States and between Canada and the United States; and that we adopt a strategy of targeting emission sources with whatever makes the most sense.

There are some plants that probably ought to be closed down. There are other plants that ought to have scrubbers put on them. There are other places where coal washing is the best strategy.

A mix of strategies is what is required here. We are not going to do any of this, however, without the commitment and political willpower to address the problem and to pay the costs over a period of years.

This is what disturbs us so much about the administration's views. According to what we have read in the newspapers, Mr. Stockman, for example, pretends that acid rain is just not a problem. He doesn't think it is a problem. If you don't think it is a problem, everything else that is happening follows from that.

We have to admit it is a problem.

I want to make one other point: we do a lot of work with the Canadians. Over the last 2 or 3 years, there have been numerous meetings between Canada and United States environmental organizations. There was a very large acid-rain precipitation conference in Toronto 2 years ago that surprised everybody by drawing literally hundreds of participants from all over the North American Continent.

I share your views about the anger of the Canadians. It is a quiet, understated type of concern and rage, but there is no doubt that they feel this is one of their absolute high priority problems; it is a problem that they are angry about with the United States, because they see they are trying to do something and we are not trying to do anything.

The Canadian Government passed an aide-memoire, I think a month or so ago, to our government, outlining the five or six major steps they thought they had taken in the last year to address the acid rain problem, including clamping some very stringent controls on their biggest smelters up at Sudbury, amending the Clean Air Act to give reciprocity with the United States and in a variety of other situations, moving to meet the problem instead of hide from it.

All they see from us is that we allow SIP relaxations in certain States, we allow taller stacks to be built, and so forth. We are slapping Canada in the face. There is a serious foreign relations problem in addition to the environmental problem.

Canada wants very much to cooperate in every way possible with the United States to solve this problem. It is really up to us to make the next step.

[The prepared statement of Mr. Barnes follows:]

28 May 1981

STATEMENT OF JAMES N. BARNES ON BEHALF OF AMERICAN LITTORAL SOCIETY, ENVIRONMENTAL ACTION, ENVIRONMENTAL DEFENSE FUND, FRIENDS OF THE EARTH, GREAT LAKES TOMORROW, IZAAK WALTON LEAGUE OF AMERICA, NATIONAL AUDUBON SOCIETY, NATIONAL PARKS AND CONSERVATION ASSOCIATION, NATIONAL WILDLIFE FEDERATION, NATURAL RESOURCES DEFENSE COUNCIL, SIERRA CLUB, WILDERNESS SOCIETY

BEFORE THE ENERGY DEVELOPMENT AND APPLICATION AND THE NATIONAL RESOURCES, AGRICULTURAL RESEARCH AND ENVIRONMENT SUBCOMMITTEES OF THE HOUSE SCIENCE AND TECHNOLOGY COMMITTEE CONCERNING ACID RAIN

I am James N. Barnes, an attorney with the International Project of the Center for Law and Social Policy, a public-interest law firm in Washington, D.C. We appreciate the opportunity to present this statement on behalf of twelve environmental organizations: American Littoral Society, Environmental Action, Environmental Defense Fund, Friends of the Earth, Great Lakes Tomorrow, Izaak Walton League of America, National Audubon Society, National Parks and Conservation Association, National Wildlife Federation, Natural Resources Defense Council, Sierra Club and the Wilderness Society. */ These organizations have been actively involved in developing public awareness of the acid rain problem, and in proposing solutions, both short and longer term.

We welcome this Committee's interest in acid rain. This phenomenon raises issues which far transcend the interests of environmental organizations. Acid rain adversely affects forests, crops, fish, species dependent on a viable lake and river ecological

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*/ Attached as Appendix A is a description of these organizations.

Ann Merryfield, a law student intern at the Center, assisted in the preparation of this testimony.

base and human structures of all types. Moreover, it is an international issue that affects the relations of nations. For Canada acid rain is one of its most serious foreign relations problems with the United States.

While we come before you today primarily to discuss the government's role regarding research on acid rain, we would like to take this opportunity to review the facts as we perceive them, the implications of these facts, and the suggestions of environmental organizations for an international plan to combat the problem. At the outset we also wish to direct your attention to various initiatives of the Reagan Administration which, if allowed to be carried out, will be very harmful to our relations with Canada, to say nothing of their impact on timely development of solutions to the acid rain problem.

Last week OMB rescinded $100 million from EPA's budget. A substantial portion of this amount is to be absorbed by R&D programs at EPA. As a result, all unobligated research funds have been frozen, including most of the acid rain research. Even funds earmarked to carry out the cooperative research effort with Canada apparently have been frozen. We also understand that the Administration is about to order the bilateral working groups of scientists from the two countries to stop work. We urge this Committee and all members of the Senate and House to require an analysis of how such steps will affect our international obligations, and our relations with Canada.

I. The Acid Rain Problem

A great deal of controversy presently surrounds the acid rain issue. This debate now centers around whether there is enough evidence about the causes and effects of acid rain to justify action at this time or whether further research is needed before any sound decisions can be made. Although we agree that more research on the issue is vital, the research that has been completed shows that the problem does exist and that it is serious. */ This present research should constitute the base for our future research programs in an effort to learn as much as possible as fast as possible. It should also be seen as a proper basis for changing national policy so that the problem can be abated.

Based on the present state of knowledge, it is fairly clear that acid rain is caused by emissions of sulfur and nitrogen oxides. These pollutants are often transported far from their point of origin, transformed in the atmosphere into acids, and deposited from hundreds to thousands of miles downwind. Large coal fired power plants are the major sources of acid rain-causing pollutants in the eastern half of the nation. Smelters are the largest sources of such pollutants in the West. Huge amounts of SO_2 and NO_x are often projected up to 2,000 feet high into the air by tall smokestacks.

In those regions where acid precipitation falls, there are many lakes which have become too acidic to sustain any form of

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*/ Attached as Appendix B is a more detailed summary of acid precipitation research.

aquatic life. The National Commission on Air Quality recently concluded that

> "The most likely source of increased river and lake acidity over a relatively large geographic area. . . is atmospheric deposition of acid material through both dry and wet processes." (NCAQ Report, p. 2.1-71.)

Canada has lost thousands of lakes and tens of thousands more are critically threatened. In the Adirondack Mountains in New York 228 lakes are already "dead" (U.S./Canada Memorandum of Intent, Working Group I Report "MOI WG-I" p. 3-21) and hundreds more are threatened. The dead Adirondack lakes represent 3.9% of all lakes in the region, and fully 25% more are already categorized as "critical", which means that they are rapidly losing their capacity to buffer the acid in-flow. (WG-I, p. 3-21). In the U.S. effects from acid rain have been documented in all of the Eastern states, all states on the West Coast, and in pockets in the Midwest. (U.S.-Canada Research Consulting Group, 2d Annual Rept.).

> "Acid deposition is currently being observed in most of eastern North America. Within this half-continent are large areas in which the surface soil material and bedrock types have little buffering capacity for acid inputs and are identified as 'potentially sensitive.' These areas include some of the most unique, unspoiled and biologically productive environments in North America. The potential is high for environmental degradation from the deposition of acid and other pollutants." (WG-3A, p. 12)

The National Clean Air Coalition has identified the following damages that acid rain, acid snow and dry deposition cause the environment:

- In the United States, all fish have been killed in several hundred lakes, and tens of thousands more lakes and streams are threatened in the U.S. and Canada.

- Acid rain is causing significant damage to buildings, monuments, paints, and other materials.
- Experiments show that acid rain damages some important commerical crops.
- Acid rain leaches important minerals and nutrients from soils. This effect may eventually seriously affect forest yields.
- Acid rain may threaten human health by leaching toxic metals into the drinking water of areas that rely on wells and other untreated supplies.

II. The International Problem

Research programs in a number of countries have shown that acid rain is an international problem. Regarding North America, the U.S.-Canada Research Consulting Group has studied the Long Range Transport of Air Pollutants (LRTAP) over the past three years. The most recent RCG report, released in November, 1980, indicates that approximately 50% of Canada's acid rain problem originates in this country. The report emphasizes the need for the U.S. and Canada to work cooperatively to abate the problem and states that "by the year 2000, both SO_2 and NO_x emissions for North America will likely be about 30-35 million metric tons annually, unless further governmental control measures are implemented." (RCG, 2d Report, p. 4. Emphasis added.)

In addition to the affected areas in the U.S. and Canada much has been documented about the devastation of Scandinavian lakes, which have been suffering the effects of acidification for over 20 years. A nine-year research program in Norway concluded that *all* lakes in a 13,000 square kilometer area of southern Norway are now empty of fish and that lakes and rivers in another 20,000 square kilometer area have significantly reduced fish stocks. (World Environment Reporter, "WER", 4/13/81). The World Environment Reporter recently reported on Irish Meteorological Service statistics which indicate that the acidity of Irish rain has increased over the last two decades. The Irish researchers are now concerned about the potential adverse effects on fishing and agriculture. (WER, 4/13/81).

The research indicates that regardless of disputes over actual causes and effects of acid rain, the issue has become a problem of international dimension, and the U.S. must seek solutions to the problem in the international arena. The U.S. must recognize that the strong concerns voiced by the Canadian government and Canadian citizens have a valid basis and that the U.S. has an obligation to take responsible action. Canada must have U.S. cooperation in order to solve this problem.

A recent statement of the Canadian Ambassador emphasized that country's concern over the acid rain problem and its desire to work cooperatively with the U.S. in finding a solution:

> "Air pollution does not respect political boundaries. When travelling long distances, such pollution not only does environmental damage, it distorts market forces. It allows polluters to reduce costs of production by exporting pollution, and it imposes economic costs on those whose health, property

> or resources are harmed. Our clean air laws were written with an eye primarily to reducing the intense local pollution that used to distinguish some of our industrial centres. They were not designed to deal effectively with the consequences of pollutants travelling long distances and crossing political boundaries.
>
> "A main feature of long range air pollution, and the one of principal concern to Canada, is acid rain. While much remains to be learned, the picture presented and agreed by the vast majority of independent scientists leaves no room for doubt: acid rain, created largely by the burning of coal and the smelting of ores, is causing severe and essentially irreversible damage to tens of thousands of lakes and streams in both our countries, and if unchecked will destroy important recreational and tourist resources. Recent research suggests acid rain degrades sensitive soils, thereby jeopardizing Canada's largest industry, forests. And damage to man-made structure is also high.
>
> "Canada and the United States have a long history, unequaled by any other countries, of resolving environmental problems in a fair, responsible and pragmatic fashion. We now need a bilateral air quality agreement to enable us to do just that: not to establish elaborate new regulatory strategems, but to undertake effective actions that would begin the task of substantially reducing emissions of acid causing pollutants as we continue to firm up our scientific understanding. While taking care not to cause socioeconomic dislocation, we must develop the political will to control the environmental, social and economic inequities inherent in transboundary pollution." (emphasis added).

The U.S. and Canada must therefore work together in researching this joint problem. Both countries have long cooperated on transboundary environmental problems. In 1909 the two countries concluded a Boundary Waters Treaty, including a provision that

> ". . . boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property."
> (Art. IV, Boundary Waters Treaty of 1909.)

Both nations have expressed commitment to international environmental quality in their acceptance of the 1972 Declaration of the U.N. Conference on the Human Environment. Principle number 21 of the Declaration states that

> "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to insure that activities within their jurisdiction or control do not cause damage to the environment of other states or areas beyond the limits of national jurisdiction." (Stockholm Declaration on the Human Environment, U.N. Doc. A/Conf. 48/14) (emphasis added).

In 1972, the two nations concluded the Great Lakes Water Quality Agreement, one of the first international accords to set water quality standards for boundary waters. This agreement was replaced in 1978 by a new accord outlining more specifically the steps toward achieving water quality goals. This accord includes an agreement to consult on remedial measures in regard to Great Lakes pollution resulting from atmospheric deposition.

In 1978 the two governments established the bilateral Research Consultation Group (RCG) on the Long Range Transport of Air Pollutants (LRTAP) as a step toward U.S./Canadian cooperation under the larger U.N. Convention on International Air Pollution, prepared by the Economic Commission for Europe. The RCG has published two reports thus far which confirm that acid rain is an international issue and must be solved cooperatively.

In recognition of the severity of transboundary air pollution, both countries signed the August 5, 1980 Memorandum of Intent in which they pledged to "increase bilateral cooperative action to deal effectively with transboundary air pollution, including acid rain."

This agreement was the first step toward implementing goals originally agreed upon by the U.S. and Canada in a Joint Statement on Transboundary Air Quality on June 26, 1979. While the Memorandum of Intent is not a binding international agreement, it is evidence of each government's recognition of the existence of the acid rain problem and it obligates both countries to act consistently with its purposes.

In the Joint Statement and the MOI, both countries agreed to work toward the swift negotiation of a Transboundary Air Quality Treaty. In particular, the governments agreed to "maintain and further develop a coordinated program for monitoring and evaluation of the impacts of transboundary air pollution," and to "continue to exchange information in research and develop improved technologies." The MOI established five working groups to compile and analyze information on all research surrounding the acid rain problem. Pursuant to this agreement, the working groups published in February, 1981 their interim reports. The reports contain a wealth of information, and if completed should be invaluable in negotiation of a treaty and abatement of the problem.

Although the United States has officially expressed through several treaties and agreements its commitment to international coöperation for environmental quality, in practice we have done very little to adhere to these obligations insofar as acid rain is concerned. Our participation in the Working Groups established under the MOI is the one exception to that lack of action. We feel it is vitally important that our participation continue and that an agreement finally be negotiated. As we indicated earlier, any action that would undercut the commitments already made to Canada would raise very serious diplomatic problems.

Otherwise, our record has not been good. The Carter Administration decided to propose major legislation in 1980 to shift some oil-fired generating plants to coal. The government's own studies showed that this would increase substantially SO_2 and NO_x emissions along the Canadian border, but the concerns of Canada and others were ignored. During the last two years dozens of relaxations of State Implementation Plans under the Clean Air Act have been approved by EPA, almost all of which result in increased SO_2 and NO_x loadings, which in turn contribute to acid rain in the northern U.S. and Canada. Numerous relaxations have been granted by EPA for construction of tall stacks, which greatly increase the long-range transport of pollutants, and this aggravates acid rain. Yet the U.S. agreed with Canada last year, in the Memorandum of Intent dated August 5, 1980, to take interim action under existing law to combat acid rain, and to vigorously enforce existing law. We have not lived up to our commitments.

III. The Need for Continued Research

We urge that Congress continue to allocate funds for studies being carried on by U.S. researchers. Studies such as are outlined in the Draft National Plan and proposals by the bilateral Work Groups established under the Memorandum of Intent will provide the base for research in the next ten years to verify the causes and effects of acid precipitation.

But we believe that the emphasis of any national research program should not be to duplicate the work of earlier investigations. There has been a great deal of scientific research done already on the acid rain phenomenon. The National Plan ought to start where existing studies have stopped rather than repeat their efforts. It should provide the short- and long-term research necessary for improved control technologies. In this regard, the MOI working groups are exceedingly important because they are attempting to compile all existing research.

In solving the problem of acid rain various planning approaches should be used. Studies have shown that the effects of acid rain cannot be properly analyzed in isolated segments, e.g., effects on soil, lakes, forest, etc. The entire ecosystem is affected and must be considered as an interrelated whole. In studying acid rain effects on the ecosystem, for example, researchers should consider:

(1) Changes in rain chemistry caused by passage through canopy and litter layers;

(2) Effects of altered soil solution chemistry in uptake of chemicals by plants;

(3) Effects of acidification on soil biological processes, e.g., decomposition, nitrification, etc.;

(4) Effects on weathering and mobilization of minerals into surface and ground water;

(5) Role of sulphate absorption by the soil in controlling the chemistry of soil solution and of base flow to streams and lakes. (RCG, p. 17).

In view of the modeling and monitoring uncertainties that do exist, we would urge Congress to appropriate sufficient funds to the Inter-Agency Task Force on Acid Precipitation to carry out its federally mandated research program. Part of that research plan will include Global and National Trends monitoring networks which will be critical for those planning and implementing abatement strategies. We support the creation of a nationally coordinated monitoring system for wet and dry deposition. This should be jointly established with Canada and implemented as soon as possible in order to document more effectively both long range transport mechanisms and substantial reductions in acid deposition once stricter controls are imposed on the sources. Such a monitoring network should be able to directly document interstate and international transboundary deposition, and should be readily useable for calculation of mass balances of each state's acid deposition imports and exports (when combined with emissions data). Further development of dry deposition monitoring equipment should be given high priority in the effort to improve this monitoring network. All such additional monitoring data should be collected with its possible use as data input for LRT and mass balance export or import computer modeling in mind.

The Draft National Plan proposes to research impacts of acid precipitation on drinking water and the potential human health effects from contamination of drinking water supplies. We encourage such research. The MOI Work Group I Report cites studies from the Hinckley Reservoir in New York State indicating that it has been acidified to the point where lead concentrations exceed maximum levels safe for human use. Studies from Pennsylvania show lead levels of cistern water 16% higher than U.S. drinking water standards as a result of acid corrosion of lead solder in joints in the cisterns and plumbing. The Report indicates that areas of particular sensitivity to drinking water contamination include:

(1) poorly buffered lakes and streams;

(2) watersheds with unusual accumulations of metals in sediments or soils;

(3) areas lacking drinking water treatment facilities; and

(4) areas with substantial lead plumbing.

In addition to calling for the precise identification of these kinds of areas and then setting up monitoring systems for their drinking water systems, we believe that the National Plan should call for a more comprehensive system of monitoring the actual concentrations of toxic material due to leaching and mobilization of metals in such particularly sensitive areas. This work should be undertaken in coordination with state, local, regional, and Canadian authorities. More systematic monitoring of exhaustion of buffering capacity, again in coordination with other appropriate authorities, should also be undertaken.

The National Plan could usefully focus on those places where drinking water contamination has occurred and conduct epidemiological studies to provide follow-up to these findings which will give us a better understanding of the effects of such contamination induced by acid rain.

Regarding terrestrial effects, the Working Group I Report summarizes the most up-to-date research needs in that area as follows:

(1) Improved system of mapping terrestrial sensitivity, incorporating such data bases as Geoecology and Ecodistrict (USA and Canada) to allow further identification of key sensitive areas;

(2) An improved soils information base, including data on depth to carbonate layer, and sulphate absorption capacity;

(3) Relationships between forest productivity and acid sensitive properties of soils;

(4) Better record of spatial and temporal measurements on impacts of acid precipitation (deposition data) in both the United States and Canada;

(5) Projections of deposition of wet and dry materials, together with chemical composition, within well defined areas in Eastern North America; and

(6) Information derived from field work on changes in base status and nutrient availability of a representative variety of soils, in relation to various deposition levels.

We encourage the incorporation of these suggestions into the Draft National Plan.

This Administration's approach to the environment and environmental issues has so far proved to be completely contradictory. On the one hand, the Administration, following industry's recommendations, claims we must research the acid rain issue before we take any steps to control the problem, especially if these steps might have adverse economic effects. At the same time the Administration undercuts the research efforts which are showing the existence of a problem. As of May 19, 1981, OMB rescinded a large portion of EPA's budget forcing a freeze on funds supporting EPA's acid rain research. This freeze will ruin many studies currently in process.

In Wisconsin and Minnesota, for example, studies have shown the bedrock to be substantially similar to that in Scandinavia and therefore susceptible to the adverse effects of acid rain. Because of the low rainfall this year, conditions now exist for excellent studies of the region. If the funds remain frozen, however, these studies may never be completed.

The Administration has even proposed to cut the funds that would have sent scientists to their very important U.S./Canada impact assessment meetings pursuant to the joint Memorandum of Intent. Not only does this jeopardize the future of crucial joint environmental assessment strategies, it also violates an international commitment to work jointly in researching a mutual problem. The United States cannot afford to lose the good will of its neighbors, just as we cannot afford to ignore the fact that many of our own lakes are dying.

IV. Control Technologies

Any research plans developed must include control technology research. In this respect the Draft National Plan is very weak. The sections devoted to identifying information needs and delineating research plans for control technologies are too general in scope and basically incomplete. The only control technology suggested for research funding over a period of 4 years, is the Limestone Injection-Multistage Burner (LIMB). While this sounds like it could be a useful control technology, it should not be the only one receiving support.

Several groups encourage coal-washing as a control on emissions. There is no doubt that this technique is beneficial to a certain extent. It could be a good interim strategy, and if coupled to other planned methods of reducing emissions it could provide a cost-effective component to a strategy. Of course, there are many different kinds of coal-washing. We mean more than that just getting rid of dirt and rock. We feel that its relatively low overall effectiveness in the long-term may make it more cost effective to invest the bulk of the available capital in some other processes. There may well be much better methods for economically reducing SO_2 and NO_x emissions. For example, early tests of a recently-developed system referred to as "Sulf-X" indicate that it can remove 90-98% of the SO_x and 70-80% of the NO_x at a lower operational maintenance cost than conventional scrubbers. Research on control technologies such as this should be well-funded and included in the Draft National Plan.

V. The Need for Abatement Action

Industry argues that more study is needed before government adopts any remedial measures. But their argument for delay requires us to ignore the growing weight of the evidence. Although the available monitoring data strongly indicate that acid rainfall in North America is increasing, some industries, taking advantage of both government's and industry's past failure to monitor more thoroughly, claim the increase has not been proved.

Although our knowledge of the acid rain phenomenon is imperfect and continued research is essential, we agree with the increasing number of scientists who have studied the problem that there is enough evidence to justify taking initial abatement actions. Here we strongly disagree with the position industry has taken. We can no longer afford to use our lack of perfect knowledge as an excuse for not taking strong abatement actions. Both for the sake of our environment as well as for our continuing good relations with our neighbor to the North, we must begin now to take constructive action to abate acid rain.

In recognition of the seriousness of the acid rain problem, the National Commission on Air Quality recently recommended that Congress require "a significant reduction by 1990 in the current level of sulphur dioxide emissions in the eastern U.S." We agree with the Commission that there is ample justification for immediate action to be taken to abate acid rain and endorse that recommendation.

One of the most frequently cited justifications for not taking action at this time is the claim that the monitoring data we have available now is unreliable and sparse and that the various mathematical models which have been developed cannot be considered seriously until the data on which they are based is more certain. These arguments ignore the fact that where there has been comprehensive monitoring, as in Scandinavia, the results clearly show that acid rain has increased as transported sulfur and nitrogen emissions have risen. Certainly the U.S. and Canada should learn a lesson from the European-Scandinavian experience with acid precipitation, and not wait until our problem reaches the level of severity that it has reached in Scandinavia.

Delaying action to reduce acid rain may cause irreversible damage. A recent National Academy of Sciences report cites an estimate that as of 1978 acid rain caused about $5 billion in damage per year. The effects of acid fallout are cumulative. Every additional year that the present acid rain rate continues, the damage will increase. In many sensitive areas we are well beyond the critical point where nature can no longer withstand the enormous burden of additional pollutants. We must reduce that burden of additional pollutants, or face major damages to our environment.

Scientists who have devoted their careers to the study of acid rain have concluded that we know enough now to identify a virtually foolproof first step in reducing acid rain -- reduction of sulfur and nitrogen oxide emissions. The longer we wait to take the step, the greater the damage to our environment will be.

A. Inadequacy of the Clean Air Act

The Clean Air Act has proved inadequate to the task of controlling the acid precipitation problem. As the NCAQ has pointed out, the emphasis in the Act is on controlling local, ground-level pollution. This emphasis has encouraged control strategies which disperse pollutants over wide areas, reducing only local concentrations. One such strategy has been the use of tall stacks. Another problem under the existing Clean Air Act has been that the SIP revision process has been used to allow states to relax their SO_2 emissions limits.

Perhaps the most objectionable aspect of the Clean Air Act is its failure to ensure both interstate and international dialogue and cooperation for coping with mutual pollution problems. Canada has not been able to provide any signficant input into the EPA proceedings on SIP revisions. Source states have had little or no incentives to consider the impacts of their emissions downwind on other states or countries. This situation is in direct contradiction to our stated policies favoring international cooperation and mutual solutions to a common problem.

The only plausible cause of rain indicated by research to date is emissions of sulfur and nitrogen oxides. The most plausible cure is to substantially reduce those emissions over broad areas of the U.S. and Canada. Based on analyses already done it is clear that substantial sulfur oxide reductions can be accomplished with only small economic impact spread over a large region. Studies cited by the National Commission on Air Quality indicate that the U.S. could reduce sulfur oxide emissions by 7 million tons per year and still only raise average Eastern electricity rates by less than 2%.

B. Recommendations for Abatement Action

The National Clean Air Coalition proposals for an acid rain control program would significantly reduce present levels of sulfur oxide emissions by 1985. The Coalition has suggested the following steps:

(1) Congress should specify in the Act the total emissions reduction to be accomplished by the initial acid rain abatement program;

(2) Congress should identify the source categories whose emissions must be reduced and should apportion the total reduction target within those categories;

(3) Sources should be allowed to meet their portion of the total reduction target by trading with other sources in the region. This "regional bubble" approach will allow the total reduction to be achieved at the least cost;

(4) Utility sources should be required to analyze the additional emission reductions which could be accomplished by making investments in energy conservation measures;

(5) Increases in emissions of sulfur as a consequence of converting oil fired power plants to coal should be prohibited. Such a program should allow use of the "bubble" approach to minimize costs;

(6) EPA should be required to set strict New Source Performance Standards for industrial boilers within one year;

(7) EPA should be required to fund commercial demonstration of improved technologies for controlling nitrogen oxides from fossile-fuel fired boilers within three years;

(8) Congress should establish physical limitations on stack heights in order to reduce long-range transport of pollutants; and

(9) Existing controls on mobile-source nitrogen oxide emissions should be retained.

In achieving these reductions, the Coalition has supported the inclusion of conditions in the program to prevent loss of mining jobs.

We would also suggest that, based on current evidence, Congress should enact a moratorium on further construction of tall stacks, and also on relaxations of existing State Implementation Plans that would result in increased SO_2 and NO_x emissions.

C. Resolution of the Canada-United States Environment Council

This group of more than forty Canadian and U.S. environmental organizations met in Washington on March 19-22, 1981. The group unanimously passed the following Resolution on Acid Rain:

WHEREAS on August 5, 1980 the United States and Canada signed a Memorandum of Intent and agreed to work cooperatively to abate acid rain precursor emissions; and

WHEREAS that agreement binds each country to act to the fullest extent possible under its own laws to curtail hazardous SO_2 and NO_x emissions; and

WHEREAS the United States is able, under Section 115 of the Clean Air Act, to take action to revise state implementation plans (SIPs) in states contributing to acid rain in Canada; and

WHEREAS Canada recently amended its Clear Air Act to provide the same protection to the United States that Section 115 provides to Canada,

NOW, THEREFORE, BE IT RESOLVED that:

(1) The United States should act expeditiously under Section 115 to abate to the fullest extent possible under existing law SO_2 and NO_x and toxic-metal emissions which are contributing largely to the acid precipitation in Canada and the U.S.; and

(2) Canada should act expeditiously under Section 21.1 and Section 21.2 of the Clear Air Act to abate to the fullest extent possible under existing law the emissions that are contributing to acid precipitation in the U.S. and Canada; and

(3) The United States and Canada should work with fullest cooperation toward the completion of a Transboundary Air Quality Treaty which establishes the goal of reducing the emissions to approximately those levels prevailing in 1955; and

(4) The United States and Canada should take certain immediate steps to reduce the emissions at existing facilities through the following mechanisms:

  (a) requiring the washing of all coal to reduce emissions;
  (b) implementing a Least Emissions Dispatching (LED) policy at existing facilities, which would require use of newest and cleanest equipment first at any given facility, with older, more polluting equipment brought on line only for peak load times; and

(5) The United States should not allow relaxation of emission limits in any state implementation plan currently under review; and

(6) All governmental levels in the two nations should work together and jointly with nongovernmental groups to inform the citizens of both nations of the actual and potential harms from acid precipitation.

(7) All state and federal agencies in both nations should permit unrestricted public access to any emission data and other studies relevant to the acid precipitation question.

CONCLUSION

Solution of the acid rain problem in Canada and the U.S. will require a concerted effort by the two countries over a sustained period of time. The first step is to admit that a serious problem exists and that the governments can do something about it. The second step is to determine what goals for reduction of the offending emissions are appropriate, over a particular period of time. The third step is to allocate those reductions between the two countries and among the various regions, states and particular sources. We believe that solutions can be found which are equitable and cost-effective. Environmental organizations in the U.S. and Canada look forward to working with government and industry to develop those solutions.

APPENDIX A

THE AMERICAN LITTORAL SOCIETY is a membership organization located at Sandy Hook, Highlands, New Jersey. ENVIRONMENTAL ACTION, whose principal place of business is at 1346 Connecticut Avenue, N.W., Washington, D.C., has a membership of 22,000 persons. ENVIRONMENTAL DEFENSE FUND, whose principal place of business is 444 Park Avenue South, New York, New York, has a membership of approximately 45,000 persons and a 700-member Scientists' Advisory Committee, including members residing in 18 foreign countries. FRIENDS OF THE EARTH, whose principal place of business is 124 Spear Street San Francisco, California, has a membership of over 25,000 persons and is affiliated with "sister organizations" in 12 foreign countries. GREAT LAKES TOMORROW, whose principal place of business is 53 West Jackson Boulevard, Chicago, Illinois, is an international organization of citizens concerned with protecting the future of the Great Lakes. The IZAAK WALTON LEAGUE OF AMERICA, located at 1800 North Kent Street, Arlington, Virginia, is a non-profit membership organization with approximately 50,000 members. The NATIONAL AUDUBON SOCIETY, whose principal place of business is 950 Third Avenue, New York, New York, has a membership of approximately 425,000 persons, including members in more than 100 foreign countries. NATIONAL PARKS AND CONSERVATION ASSOCIATION, whose principal place of business is 1701 18th Street, N.W., Washington, D.C. has a membership of approximately 40,000 persons. The NATIONAL WILDLIFE FEDERATION, whose principal place of business is at 1412 16th Street, N.W., Washington, D.C., is composed of associate members and members of state affiliate member organizations, comprising over 4,500,000 persons. NATURAL RESOURCES DEFENSE COUNCIL, whose principal office is 122 E. 42nd Street, New York, New York, and which has additional offices in Washington, D.C. and San Francisco, California, has a membership of approximately 22,000 persons, including members residing in 8 foreign countries. The SIERRA CLUB, whose principal office is at 530 Bush Street, San Francisco, California, has a membership of approximately 180,000 persons, including persons residing in 67 foreign countries. The WILDERNESS SOCIETY's principal place of business is 1901 Pennsylvania Avenue, N.W., Washington, D.C.. It has a membership of approximately 60,000 persons.

APPENDIX B

Summary of Research on Acid Precipitation

1. Aquatic Effects

Of all the potential effects of acid rain on the environment, aquatic effects have been the most easily identified and most heavily documented. Work Group I under the U.S.-Canada Memorandum of Intent (WG-I) has analyzed and summarized the major studies on aquatic effects. These findings confirm that over the last few decades increasing acidity in headwaters, lakes and streams has been directly responsible for the decline and disappearance of fish populations in many northeastern U.S. and Canadian lakes and streams. The Work Group has identified the most susceptible regions in the U.S. as the Northeast, the Appalachian Mountains, the Minnesota-Wisconsin-Michigan Highlands and the Western mountain areas of Colorado, Oregon, Wshington, Idaho and California.

Research shows that acid rain affects lakes and rivers by depleting their buffering capacity. When the buffering capacity of a lake is used up, the water rapidly acidifies. The "transition phase", the time during which the buffering capacity is on the decline, is the crucial last stage at which abatement action must be taken. (WG-I, 3-69). Once the water is acidified, the damage is done and it is essentially irreversible. (WG-I, p. 3-62). Scientific evidence indicates that acidification is a fairly rapid process. The U.S.-Canadian International Joint Commission reported in November 1980 that

> Some lakes in the Muskoka-Haliburton area have lost 40-75% of their acid neutralizing ability in a decade or less. (IJC, p. 50).

They report further that

> Many inland lake ecosystems in the most susceptible part of the [Great Lakes] Basin may be irreversibly harmed within 10 to 15 years. (IJC, p. 50).

Consequently, as the buffering capacity is lost and pH levels drop, fish eggs and young fish begin to die. The MOI Working Groups report as follows:

> In the field, there have been several reports of fish kills apparently caused by acidification of rivers and lakes. For example, Jensen and Snekvik (1972) report mass mortality of Atlantic salmon, and Leivestad and Muniz (1976) report a brown trout kill. Both fish kills have been attributed to low pH. In North America, Harvey (1979) has reported a kill of several species, primarily pumpkinseeds, from Plastic Lake in Ontario, during the spring snow melt.
>
> Results from field studies also suggest that the effects of chronic pH toxicity follow a predictable sequence of events. Decreased pH is often more destructive to younger life stages, and may cause reproductive failure (Beamish and Harvey, 1972), so that a population will first suffer from low pH by having reduced recruitment. As the pH decline continues, a total failure of one or more year classes may occur as illustrated by Ryan and Harvey's study of yellow perch in Patten Lake, in the LaCloche Mountains (Harvey, 1979). (WG-I, p. 3-52)
>
> In Nova Scotia comparisons of recent data with results from the mid 1950's show decreases in pH and concurrent increases in excess sulphate loads. At present there are 9 rivers in this province with a pH of 4.7 which no longer support salmon or trout reproduction; 11 rivers are in the pH range 4.7-5.0 where some juvenile salmon mortality is probably occurring; and 7 rivers are in the pH range 5.1-5.3 which is considered borderline for Atlantic salmon. If current acid loadings continue, it appears probable that more of the inland and Atlantic salmon fisheries in Canada will be lost.

> A similar 17-year trend toward acidification of some headwater streams has been observed in New Jersey. As well, high elevation lakes in the Adirondacks have shown a marked pH decline over a 40-year period. This is one of the most sensitive lake districts in the eastern United States. A recent inventory has indicated that at least 180 former brook trout ponds will no longer support trout because of acidification.
>
> A summary of several Canadian lake studies supports the conclusion that acidic precipitation has reduced the alkalinity of surface water in many lakes, thus increasing their vulnerability to continued acid deposition. (WG 3A, p. 16).
>
> Laboratory studies have indicated that fish are particularly sensitive to low environmental pH in their reproductive phases. Low pH can inhibit gonadal development, and also reduce egg production and egg and sperm viability, resulting in reduced spawning success. The fry are often more sensitive to acid stress than are eggs, particularly at pH's near 4.0 (reviewed in Fromm, 1980, and Spry and Wood, 1980). Consequently, fry are particularly vulnerable to the low pH episodes associated with spring meltwater or storm events. (WG-I, p. 3-52)

Not only fish but the entire aquatic ecosystem appears to be affected -- micro-organisms, amphibians, and zooplankton. In lakes which have become acid, microorganisms, zooplankton and amphibians have disappeared along with the fish populations. When the aquatic life of a lake disappears, avian and mammalian species which feed upon the fish also disappear from the region. It is fortunate that right now if one Adirondack lake "dies" the avian and mammalian life can move on to a nearby lake which is not yet dead. If acidification continues at the present rate however, there will be fewer and fewer "live" lakes for these species to turn to. MOI Working Group 3A reports, for example

> Many species of frogs, toads and salamanders breed in temporary pools which are susceptible to pH depression due to the rapid flushing of accumulated acid during spring snowmelt. Field surveys in North America and Europe have documented the sensitivity of amphibians to depressed pH and the decreases in their number, especially, those inhabiting temporary pools. The danger that they may become locally extinct and their importance in the foodchain hold important implications for other wildlife. (WG-3A, p. 16)

2. Terrestrial Effects

Although perhaps less well documented than the aquatic effects, recent research is beginning to produce evidence on the effects of acid rain on soils, vegetation and crop yields.

Acid precipitation leaches nutrients and minerals and toxic metals from soils. These flow into the groundwater and show up in lakes, streams and in some cases drinking water supplies. Soils, like lakes, have varying capacities to buffer the acid inflow. Highly organic or calcaceous soils have almost infinite buffering capacity, while sandy, rocky soils have very little capacity. Areas where the underlying bedrock geology is composed of granite, sandstone and quartzite have much less buffering capacity than regions with organic soils (WG-I). The Second Report of the U.S./ Canada Research Consultation Group (RCG) reported that all of the Eastern half of the U.S. as well as most of the West Coast have a bedrock geology which makes it susceptible to acid precipitation.

Studies have shown that acidification of soils can affect plant photosynthesis and other plant processes. (RCG Report, Ohio River Basin Energy Study, ORBES). Plant crops studied have suffered yield reductions and foliar damage. Some of the most adversely affected crops studied so far include radishes, beets and carrots, followed by various leaf crops including mustard, green spinach, chard, and lettuce.

Working Group 3A reports that at ambient concentrations of .05 to .10 ppm during continuous or intermittent exposure periods, loss of plant tissue may approach 15-30% and yield losses of 5-10% may occur for the most susceptible crops. "Direct effects of acid precipitation, especially on crops for which the foliage is valued, have also been established under experimental conditions." (WG-3A, p. 13)

3. Drinking Water and Health Effects

No direct effects to human health have been documented from acid rain although indirect effects can be expected from contaminated drinking water supplies and from increased levels of mercury and other heavy metals in fish. Mercury is leached from soils by acid rain, deposited in streams and headwaters and has been found in dangerous quantities in fish which live in waters receiving acid inflow. Working Group I cites studies which have shown that water supplies in the Hinckley Resevoir in N.Y. State are contaminated by leachants through acid rain inflow and that 16% of cistern water users in Pennsylvania had lead levels above the U.S. safety level. These increased lead levels have been attributed to lead solder in pipes which was leached by the acid water.

The Report indicates that areas of particular sensitivity to drinking water contamination include:

(1) poorly buffered lakes and streams (with viable fish populations);

(2) watersheds with unusual accumulations of metals in sediments or soils;

(3) areas lacking drinking water treatment facilities; and

(4) areas with substantial lead plumbing.

Scientific evidence continues to show that acid deposition causes leaching of toxic metals form the soil into water systems which could affect drinking water supplies over the long-term. (RCG, p. 18). For example, the RCG study has found that aluminum is common in acidified waters. When the toxic metals show up in water supplies most municipal water treatment plants are not designed to adequately treat these metals.

Although acid rain has only indirect human health effects, studies have shown that SO_2 emissions can have severe effects on human health. The ORBES Study estimates that SO_2 emissions and resulting sulphate pollution would directly contribute to 163,000 deaths from pollution related respiratory diseases as well as result in billions of dollars of crop losses in the Ohio River Valley if no stricter emissions controls are imposed between now and the year 2000. This study estimates that 54,000 pollution related deaths per year could be averted by stricter emissions controls. Richard Wilson, in a book entitled Health Effects of Fossil Fuel Burning, cooborates the ORBES findings. He estimates that 53,000 deaths per year could be associated with sulphate related pollutants (p. 219).

4. Materials Damage

Studies have shown that acid precipitation accelerates corrosion and erosion of buildings, monuments and other manmade objects. Certain building materials are particularly susceptible to corrosion in acid precipitation regions, e.g., carbonate containing materials, such as limestone and marble. One example of the serious effects acid rain can have on objects is the surface flaking that has occurred in New York City to the ancient Egyptian obelisk, Cleopatra's Needle (circa 1500 B.C.) which had survived 3000 years relatively unharmed before being exposed to the pollutants. The Council on Environmental Quality estimated that approximately $1 billion in damages to building materials in the U.S. each year are due to corrosion/erosion from air pollutants. The OECD reported that a 50% reduction in SO_2 emissions, based on an expected 1985 reduction of24.4 million metric tons could result in a benefit of approximately $1.16 billion per year in reduced materials damage. The materials damage includes corrosion of metals and erosion of masonry materials, especially carbonate containing materials such as limestone or marble which are the most valuable.

Working Group I emphasized the importance of studying the effects of acid rain on manmade materials:

> It is recognized that the architectural and sculputral expressions of our two heritages are a non-renewable resource of the most precious sort. Historic structures and monumental statuary represent the most visible aspects of historical and cultural evolution. . .

> Preservation of original material or fabric is intrinsic to maintaining the cultural value of architectural and sculptural works. The patina of history cannot be replicated; natural materials incorproated into man-made structures cannot, in most cases, be duplicated today, and, in any case, are subject to replacement in cost/benefit analytical terms. (WG-I, p. 16-2)

This Working Group reports on several studies presently being conducted on man-made materials. Among these are the folowing two:

> The Cathedral in Cologne, West Germany, has suffered much deterioration from its urban-industrial environment (Luckat, 1976; Seneviratne, 1976). In contrast, Ludwig II's Neuschwanstein Castle, built of stone from the same quarry at the same time that Cologne Cathedral's 200-year building program was completed, offers a real-world controlled sample. The stone at Neuschwanstein shows no sign of deterioration, in contrast to the crumbling stone of the Cathedral. Atmospheric sulphate decomposition at Neuschwanstien measures 6-8 mg/m^2/day compared to 130 mg/m2/day in the Cathedral area. In both cases, however, it should be noted that the exposed, deteriorated structures are being subjected to extremely high local levels of pollution.
>
> A recent study in Ottawa, Canada, has documented the consequences of both material dissolution and internal fracturing of sandstone buildings (Weaver, 1980). In this instance, substantial deterioration is probably less a consequence of local pollution than of a pollution carried from long distances. However, acid deposition is causing release of pollutants trapped in the stone in past years, causing increased damage. Ottawa is essentially a non-industrial city, but its rain has an annual average pH of less than 4.5. (WG-I, p. 6-7)

5. Monitoring Studies

European scientists began a large international monitoring network in the mid-1950's, which has been continued intact until the present. However, monitoring has not been consistently maintained in North America, although there are a number of monitoring systems in operation now which will continue to collect data.

There are currently three types of monitoring networks in the U.S. and Canada. Each type is designed with somewhat different goals in mind. The Global Trends networks measure precipitation chemistry in remote areas to monitor the global spread of pollution. The National Trends networks, e.g., CANSAP and NADP are long term country-wide national networks. The U.S. NADP network is a cooperative one involving several U.S. agencies. Working Group II has assessed the Atmospheric Modelling of Acid Rain and concluded that "National precipitation chemistry monitoring networks in Canada (CANSAP) and the U.S. (NADP) are beginning to produce comprehensive, reliable data on a continent-wide basis, and long-range transport models (LRT) have been able to estimate the order of magnitude of inter-regional transport and deposition for large areas." (Emphasis added, WG-3A p. 22).

The third type of network is that designed primarily as a back-up to research studies in atmospheric deposition, chemistry and modeling. Such networks include those of EPRI and MAP3S. In evaluating the results of these networks it is improtant to keep in mind the purpose for which they were designed and the limitations those purposes will have put on the implementation of the monitoring network.

Despite the problems in monitoring techniques and the uncertainties in results, the studies have generally shown that pollutants do travel long distances and come down as acid precipitation hundreds of miles away. The National Commission on Air Quality recently stated that

> some types of air pollution disperse from the source and travel in the atmosphere for distances of at least 1,000 kilometers. . . . The long range transport of air pollutants, particularly of pollutants contributing to acid deposition, has become an international concern. (NCAQ Report, p. 2.1-7).

On the basis of these findings the Atmospheric Modelling Work Group concluded that there was sufficient evidence upon which to base preliminary abatement strategy decisions.(WG-II, p. 7-2).

Mr. SCHEUER. Will you give us some specifics on what you think we ought to be doing in the Clean Air Act?

Mr. BARNES. We are going to be presenting a package of proposed amendments to the Clean Air Act in the next month or so. We haven't quite completed them, but in general I can outline what I think they will consist of.

They will require the Administrator of EPA and the States involved to take into specific account the impacts of their emissions on other States in setting implementation plans, in modifying plans, in developing standards, so that we look at the problem from a regional and a national/international basis instead of just a local basis. That is the first important thing. That is a basic recognition the problem exists and deserves to be addressed.

Second, we are going to be proposing that a significant goal for reducing emissions be adopted; that it be phased in over a period of years. It might be 10 years or whatever seems the most feasible, and that will be tied to the concept that utility rates should not increase by more than a certain percentage, if at all possible, so that we can keep the economic impact manageable.

Finally, we will have a number of substantial and precise recommendations about the priorities of research that we think are most important. As I said a minute ago, one of the more important areas we see being ignored right now is controls research—the various methodologies and technological fixes that could help us solve this problem. We think a lot of attention needs to be put on that, coupled with the commitment to reduce emissions.

Our long-term goal, sort of a philosophical goal right now, is to reduce SO_2 and NO_x emissions to 1955 levels. If we go back to 1955, the evidence seems to suggest that we were not having any of these acid rain problems except on maybe a fairly localized basis in 1955, and as a long-term goal, I think we would like to see the emissions roll back to that figure.

That is a very substantial reduction, and it will take a substantial commitment to reach this. We are not saying it should happen overnight. We see this as being a long-term process.

Mr. SCHEUER. You are talking of emissions from stationary sources?

Mr. BARNES. Yes.

Mr. SCHEUER. How does the automobile enter this equation?

Mr. BARNES. The automobile plays a very significant role in emissions of nitrogen oxide, obviously. We have not developed definite positions on additional controls on that right now. We think from the evidence we see so far, going after the stationary sources, whether smelters, powerplants, or whatever, is the most efficient way of attacking the problem right now.

We already have a lot of controls on autos, obviously, that have alleviated some part of the problem, and it seems from a political point of view difficult to do much more on auto emissions at this time.

Mr. SCHEUER. I have a number of questions, but I am going to turn to my colleagues first.

Mr. FISH. Mr. Flacke, I want to talk to you about cleaning coal, either before, during or after combustion. You came out for washing it beforehand. Now, I thought an alternative that would be just as important is more effective and cleaner ways of burning coal. I wondered if the New York PUC has evaluated various methods of doing so, like atmospheric and pressurized, fluidized bed combustion technology.

Mr. **Flacke**. We, in connection with NYSERDA—New York State Energy Development Corp.—have invested, in totality, about $20 million of State and Federal money with grants in a wide variety of measures as to how to burn coal more efficiently and cleaner and in a better way.

Each one of the grants that we have out with General Electric Co., private resources, and so forth, have at this point in time not reached the stage where we have definite evidence that we can conclude our research and make definite investments in our utilities and powerplants.

That is one of the problems that is connected with New York State's coal conversions in that we desperately need to convert, but the technology that is available today may very well be gone in 4 or 5 years, and the investments we make may be wasted.

So we are trying to balance out, of the 27 powerplants in our State energy master plan targeted for conversion, that we do them incrementally. We are working on five at this point in time. Hopefully, the remainder of the powerplants will be able to use the technology in which we have invested our dollars to achieve cleaner and better coal burning.

Mr. **Fish**. Switching from oil fired to coal fired in the near term, your recommendation is the washing of coal, cleaning it, in other words, before it is used. Is that to be New York State's strategy? You put it in the context of a national strategy.

Mr. **Flacke**. It is an immediately achievable strategy, one that has been commented on by a number of groups for a long period of time, but usually classified in a causal nature as, "Well, that is OK, but we ought to do a lot more." However, the fact is we have never done it, and now we must rely upon coal and the science of coal, and improvements in the science of coal will bring us an immediate return on our R. & D. dollar.

New York State's strategy is one of equity and consistency in the country. We have about the tightest State implementation plan in the United States.

As a result of the inequity and inconsistency in the past 10 years in the management of the Clean Air Act, we see some of the following things.

The country has allowed about 900 tall stacks to be created, essentially to clean up ambient air around the locality of the powerplant, and then we found a decision made that we will no longer allow anybody else to do that, so quite obviously that decision did not include from EPA the fact that we should now reduce those stacks and recognize it as a national problem.

So when one comes to find a balance between clean air States in the East—Pennsylvania, New Hampshire, Massachusetts—are not allowed to use the rule that was in force for a number of years. We also find the fact that in the early 1970's under the State Clean Air Act, we began to clean up our air, and we began to complement under our early plan an almost net execution—that is, to burn both lower sulfur coal, clean coal, and low sulfur oil—whereas in many other parts of the country they did not participate with the willingness that New York and some of the Northern States did.

In fact, they don't comply now.

So we talk about the primary air standards, and we find out that New York, for example, has good limits there, but some other States are over it or not meeting it.

We talk about SIP relaxation. We, in New York, are looking very carefully at what is happening nationally.

Mr. **Fish**. As I understand it, you are saying New York State, acting on its own in its conversion to coal-fired plants, is not the solution because the pollutants come from other parts of the country—until there is a national policy of immediately using the technology of washing coal, that it is not going to help?

Mr. **Flacke**. We would consider SIP relaxation in New York State.

Mr. **Fish**. Consider what?

Mr. **Flacke**. We would relax the State implementation plans to convert to coal until there is some effort on equity and consistency with the rest of the country.

Mr. **Fish**. From where do the pollutants come, besides our own stacks in New York State, that are causing the problems in the Adirondacks and New England?

Mr. **Flacke**. Our research indicates some of our powerplants are doing that. We are not entirely free of guilt, but evidence exists the majority of the pollution coming to the Adirondacks comes essentially from the Midwest.

Mr. **Scheuer**. Where?

Mr. **Flacke**. The Ohio Valley.

Mrs. **Schneider**. In your process of transferring to burning coal, have you done any cost-benefit analysis, or any comparative analysis regarding the process of retrofitting versus new construction of coal-fired plants?

Mr. **Flacke**. Our first phase of coal conversion takes care of five plants in New York State that did burn coal, so we can immediately go back to them, and they don't get into the new-source performance standards controversy.

Our first round includes those conversions. There is an extreme cost-benefit ratio. For example, if those five plants were able to burn the average amount of sulfur coal that is burned in most of the plants in the Ohio Valley, if not all of the plants, we would be able to save approximately $6 million a day on those five powerplants. So that is $6 million a day that is going to OPEC. It is not even going back to this country.

Mrs. **Schneider**. Thank you, Mr. Chairman.

Mr. **Scheuer**. Mr Gregg?

Mr. **Gregg**. Thank you, Mr. Chairman.

Mr. Barnes, when you talk about the failure of the buffer zones to absorb the acid types that are being dumped on them by sulphates and nitrates, I take it you are talking about conditions in mountain areas, which should be typical of New England and upstate New York.

Mr. **Barnes**. That is right.

Mr. **Gregg**. You are saying there is a runoff, and this runoff ends up in the lakes, either directly or when the snow melts.

Mr. **Barnes**. That is one component of it; it comes in many forms.

Mr. **Gregg**. How much of the problem is caused by oil-fired plants versus coal?

Mr. **Barnes**. From all we know, the great majority is coming from coal-fired plants. I can't give you a precise breakdown on the figures. For one thing, most of the seriously offending sources that feed the long-range transport of air pollution are in the Midwest, where they do burn mostly coal. They don't burn that much oil out there.

Mr. **Gregg**. You are confident it comes from the Midwest?

Mr. **Barnes**. It is not me who is confident. I am just reporting on scientific studies. The reports are not 100 percent certain scientifically but they say there is no other plausible explanation for this problem and for its creation.

They have plotted on maps that we could bring to your office and show you, through satellite photography, the plumes, themselves, actually transporting hundreds and hundreds of miles from the Ohio River Valley up into the Northeastern United States and into Canada, and those plumes are coming from powerplants. In some cases, I understand the satellite photography is so precise that you can see exactly where it is coming from.

Mr. **Gregg**. It is essentially being made in the Midwest and being dumped in New England.

Mr. **Barnes**. A large percentage of it is; yes.

Mr. **Gregg**. There is nothing, I understand, under the present Clean Air Act—there is section 127, but it is not very clear—that would allow a State like New Hampshire to take any sort of action which would impact a State like Ohio, or Indiana, is there?

Mr. **Barnes**. The act is very imprecise and not very helpful. It might be done, I think, if there was a political will on the part of the EPA Administrator to effectuate such things as taking into account the impact on New Hampshire of emissions in Ohio. At least when a SIP plan is up for approval or relaxation approval, there are certain things that could be done. Indeed, a number of States—I don't think New Hampshire is one of them—but a number of States, including New York, Pennsylvania, plus Ontario, have intervened in these proceedings at EPA to raise these kinds of issues.

So far, we have not gotten a clearcut legal determination from a court that says that EPA has to take these impacts on New Hampshire and other States into account, and, therefore, they have taken no action to alleviate the problem.

Mr. **Scheuer**. As I understand it, New York State has sued EPA for the purpose of inducing them to reject 17 applications, as I understand it, mostly from Midwest sources. Would you elaborate on that, Mr. Flacke?

Mr. **Flacke**. The Governor's program on acid rain includes a legislative strategy, where we are participating today, and also the legal strategy carried out by the attorney general, Robert Abrams. That is involved with suing individually the EPA, or where they are involved in SIP relaxations, where they, in essence, created the State implementation plan, and also the individual States that are involved.

I believe now we are involved in almost 13 or 14 individual lawsuits in that regard. The basis of those involves tracing it back to the plants and under section 126.

Mr. SCHEUER. That is a cumbersome arrangement. It is not a very good system, where a State has to sue EPA to deny permits for building plants halfway across the country.

What kind of an improved system can you suggest for evaluating costs and benefits, not in a local community or in a county or even in the State or a region, but nationally and internationally—because the Midwest is going to have to put up with some costs to save the Canadian lakes and forests as well as our own.

Have we fully developed this mechanism for measuring where the source—the source of the pollutants—the area that is the victim of the pollutants, and then on that macro-scale, measuring costs and benefits for ameliorating the problem, both nationally, as I say, and internationally?

Mr. FLACKE. We believe there is enough evidence now to implement a series of strategies to even out the balance in the country without causing economic and social harm to either area of the country.

First of all, the numerous air quality control regions lend no positive benefits toward the management of air quality in this country, so, therefore, a restriction of the air quality control region and a reduction in the number that will essentially involve themselves in what is called a corridor, so for a very cautious analysis, if we could reduce the whole country to, say, 8, 9, 10, or 11 air quality control regions, we could then have a mechanism to interact between the various States toward the achievement of a solution.

Mr. SCHEUER. Have you ever drawn such a map as to what those control regions would look like?

Mr. FLACKE. We have drawn them, and we would be glad to submit them. They have been done by both the academic community and the scientific community.

Mr. SCHEUER. I would suggest holding the record open for the submission of this information, plus what I have requested before, and also for members to submit any additional questions to any of the witnesses, and we will provide time for those questions to be answered.

There being no objection, it is so ordered.

[Some information not supplied at time of printing.]

Mr. SCHEUER. What would the region look like that would include the problem area we are talking about, the problem of New York State and Canada, with emissions coming mostly from the Middle West, from the Ohio River Valley? I guess that would be sort of a broad swath right across half the United States, the middle of the country, to the east and then north.

Mr. FLACKE. Yes, and there would be so much sulfur in that and so much sulphates, and there would be essentially a monitoring system designed for the air quality control region and a system of setoffs within the region so there is equity, social and economic.

Mr. GREGG. The chairman has brought up good points, and if we have to develop regional air quality districts—which is the proposal of both witnesses who have testified so far—we have to come up with some manner in which to assess the costs of complying with standards in each district. I have to say out of fairness, you can't ask for the production States to bear the entire cost.

Mr. SCHEUER. Would you repeat that?

Mr. GREGG. I don't believe you can ask the producing States to bear the entire costs of correcting the problem.

Mr. SCHEUER. Elaborate on that. What would you ask New York or Canada to do for a polluting source in the Ohio River Valley?

Mr. GREGG. If you are going to be producing energy which is going to benefit the country, no matter where you are producing it, I think it is a benefit to the country. Maybe the Federal Government has some sort of responsibility to participate in this funding.

Mr. SCHEUER. I want the record to note that that suggestion came from this side of the chairman's rostrum and not that side.

I commend the gentleman for his very courageous statement.

Mr. GREGG. That is a position I have taken before, Mr. Chairman. It is a situation we have lived with in New Hampshire for quite a while.

Mr. SCHEUER. You are saying there is a role for the Federal Government here?

Mr. GREGG. This is a Federal issue; there is no question about it. It is an issue which exceeds State lines. There is no question about that issue.

Mr. SCHEUER. I take it that New Hampshire is even more pure in this case than either New York or Canada, in that they are not contributing—they are contributing virtually zero percent of the pollutants that are plaguing.

Mr. GREGG. New Hampshire is one of the purest places you can ever go, Mr. Chairman. I would love to have you come there. We used to have an ad, "If you want fresh air, come to New Hampshire," or something like that. We used to run it in New York. Unfortunately, now we can't do that any longer.

Mr. SCHEUER. I might say the Canadians acknowledge a certain portion of guilt. The Canadians are producing about 50 percent of the pollutants that are plaguing them and about 25 percent of the pollutants that are plaguing us in the Adirondacks. Is that about right?

Mr. GREGG. That is about right, but they are accepting more guilt than we believe they have.

Mr. SCHEUER. That is very commendable.

As far as New Hampshire is concerned, you are in a normally more pure position than in, for example, my State?

Mr. GREGG. This is true on most issues, Mr. Chairman.

To get back to some specifics, you said you were going to present areas of priorities for research. This is something that obviously this committee has some impact on. I think the question of reforming the Clean Air Act on the issue of districts or regions will probably be within the jurisdiction of this committee, but the questions as to how we can improve research in the area of the acid rain is certainly within the jurisdiction of this committee.

Can you give us some of your thoughts, recognizing they are going to be delivered to us in more depth some specifics as to the areas where you think we should be doing research?

Mr. BARNES. In listing these, I don't mean to assign any certain categories. I will say the whole issue of control technology is very important. We don't think enough is being done on that. I again refer you to this Sulf-X system, for example, which, according to the initial tests that have been done, removes 92 percent of the SO_2 emissions, 60 percent or greater of NO_x.

Mr. GREGG. What is the procedure?

Mr. BARNES. Sulf-X is a flue gas injection process. One of the benefits is that you produce sulfur, which has a commercial value which is quite substantial.

I am not saying that the initial research shows that it will be a completely cost-effective process in and of itself, but only to suggest that there are commercial utilizations for these things that are now causing us problems, and if we are clever, we can probably figure out a way to utilize those things which once were pollutants and make them have real value for us.

Processes like this——

Mr. GREGG. How about LIMB?

Mr. BARNES. That is another one which we think has some real potential. It is the only one that is slated to be researched in the national draft acid rain assessment plan. And in comments we filed on that plan we criticized it because that was the only one they proposed to do any research on.

There are a number of what you might call high-technical solutions that don't involve scrubbers that appear to have substantial economic benefits—none of them 100 percent of the value of the technique.

Mr. GREGG. You are going to give us that list in more depth?

Mr. BARNES. Yes.

We have a number of suggestions in our testimony today about monitoring networks that need to be either added to or created that don't now exist. These suggestions are drawn from the working group reports between Canada and the United States.

If you want to continue to heighten your sophistication about knowledge of the causes of the problem, and so forth, you obviously have to have a very detailed monitoring network. The monitoring networks we have right now are beginning to be tied together by the scientists and technicians, but it is not really the kind of system they want to see, as yet.

So we would like to see some research to make certain that the monitoring networks are truly accurate.

Mr. SCHEUER. Excuse me. You mentioned before satellite photographs.

Is this a promising means of monitoring transport of pollutants, long-range transport?

Mr. BARNES. It is certainly one mechanism to identify—there are various techniques. You can use infrared photography to pick up things you can't pick up with the naked eye, but a lot of these plumes can be seen by the naked eye. I don't know how precise it would ever end up being or what is the cost/benefit of utilizing that technique.

Mr. SCHEUER. I would tend to think we would get into an awful morass, trying to assign responsibility and costs between States. I tend to agree with Congressman Dunn in his comment that this is a national matter that affects 230 million Americans.

I would hate to get into a catfight with Ohio, Pennsylvania, Michigan, wherever, on allocating costs of their pollution control—the expensive, required pollution control technology, and try to assay how much of it they should pay, what we should pay in New York, how much Canada should pay. I don't envisage that as a very promising avenue, and I presume you wouldn't, either.

Mr. BARNES. We don't think it is. We have taken a position that it is a Federal and international problem, and we have to have a holistic solution developed that equitably balances out the cost.

Mr. SCHEUER. How would you equitably balance out the cost?

Mr. BARNES. If you have a 10- or 15-year program for reducing emissions by *x* tons, and you do so much per year, you target your sources in a fairly precise way, that you want to make certain requirements of, and in that way you spread the costs around the regions, and you also can insure by determining, you know, when you are going to require this and when you are going to require the next step, and so forth, that the utility costs don't rise by more than a certain percentage in any 1 year. I think we will be able to provide to the committee more details about this in the next 30 days.

The point I wanted to make was in the past 10 years a State like New York or Connecticut has made, relatively speaking, a lot more sacrifices to reduce their emissions than has Ohio.

Mr. SCHEUER. Is there any way you can quantify that in a fair and accurate manner?

Mr. FLACKE. We have that down to dollars and cents, and it is the amount we talked about. If we were allowed to burn in five powerplants the coal that Ohio burns, we are spending each and every year $6 million a day.

Mr. SCHEUER. To avoid——

Mr. FLACKE. To avoid this situation. In other words, there is a $6 million benefit if Ohio did what we did. We would be even-steven.

Mr. BARNES. New York, Connecticut, New Hampshire, and other Northeastern States have State implementation plans that have certain goals they have agreed to both internally and with EPA. In all these cases they are not able to meet their own implementation plan goals in part because of these emissions that are coming from States that have not paid as high a burden in the past to clean up their emitting sources.

It is a tricky concept in determining where do you start in measuring equity and what is your base. It may very well be that some States have to pay a higher cost to alleviate this problem because they have a much greater gap to meet.

The emission levels might be a factor of 300 percent higher in Ohio than they are in Connecticut or New York, for example.

Mr. SCHEUER. And even assuming they are going to pass it through to the ultimate consumer through their rate base, it means that electric power consumers in the Ohio River Valley are going to have somewhat higher electric bills to pay.

Mr. BARNES. It could mean that; that is right.

If the country, as a whole, sees this as being a Federal problem and wants us to avoid these kinds of nasty fights, one partial solution is to make certain tax benefits or other benefits available to the industries that are required to put on this technology, which gets us around guilt and gets us to solutions.

That is where we need to focus attention: Where are the solutions; not the guilt.

The fact is, some States have a higher burden already, and, as indicated here today, they are continuing everyday to pay a higher burden simply because they felt it was a more important value at an earlier point in history back down the road a few years.

Mr. DUNN. Being from Michigan, I am not sure whether I should raise a white flag or come out shooting.

Mr. Flacke, I was taking some notes as you were going through your litany at the start of your talk on things that are wrong. You covered scrubbers, ERDA, university research, Congress, EPA, past administrations wasting money, and this administration which won't waste money. You don't think much about anything until we got down to the great State of New York. Everything seems to be pretty wonderful there.

I don't think you do yourself a lot of credit, if I may, by addressing the committee in this way. Mr. Barnes, I think, did a much more credible job of addressing the issue before us which is how can we approach EPA with some specific suggestions. I would ask, in further testimony, if you do have some good ideas in New York, please, rather than just criticizing all these various groups, I would request you make us aware of specific things you would like to see changed in EPA.

That is my only comment.

Mr. FLACKE. Congressman Dunn, respectfully, we have had a very difficult time with EPA over a long period of time. We have had an EPA region 2 Administrator that essentially went to our neighboring State of Connecticut and solicited 126 petitions against New York State.

We have had an EPA region 2 Administrator that said to us that we don't care about NEPA or the Environmental Quality Review Act; we want to sit down and cut up the pie with you as to whether or not we are going to have scrubbers or not.

We have had a very difficult time. We have lived through Love Canal, where we found that EPA has had repeated warning, where we advised them the studies they were going to release were no good, did not have peer review. They went ahead and released them—why, I don't know—perhaps inflammatory rhetoric for the superfund.

We are not perfect. We cause pollutants in Massachusetts and in New Hampshire. We are essentially fighting for a program where we feel we have invested a lot of money in the past and we have invested a lot of talent in trying to get those ideas across on the Federal level.

Mr. DUNN. The EPA document is several hundred pages long when it comes to clean air. If you can supply us with some things we can't live with there, which we can rewrite, that is the function of this committee. You could better serve your people by proceeding to these details, as Mr. Barnes has.

Mr. FLACKE. I have submitted those today.

Mr. **Scheuer**. Why don't you describe to us your specific recommendations? I think that is what Congressman Dunn is interested in, and I am, too.

Mr. **Flacke**. The group that worked in New York State—we tried to work with a 26-State coalition in developing a majority of the ideas, and we have also worked with our sister States of New Jersey and Connecticut on what was called the Atlantic Alliance in trying to develop some of these ideas.

First of all, the Clean Air Act failed adequately to address the long-range transport issue. We believe that is one of the major ones and that is concurrently on with——

Mr. **Scheuer**. We have talked about the long-range transport issue, and I think Congressman Dunn would join me in asking you for specific programmatic suggestions as to what kind of an amendment would solve that problem. You don't have to give us the legislative language, but if you could give us your specific thinking of the substance of an amendment to cure that problem, we would appreciate that.

If you haven't it now, you can submit it. We would be happy to hold the record open, as we are going to do, anyway.

Mr. **Flacke**. We have done that, Mr. Chairman with our submission at the beginning of this hearing.

[Information included in testimony.]

Mr. **Scheuer**. Now, give us some more of your specific programmatic recommendations.

Mr. **Flacke**. We believe sections 108 and 109 of the Clean Air Act, which has the national air quality control standards, are causing a great deal of difficulty. We essentially believe that the law can be revised to require a standard-setting process which would be based upon protection against adverse health effects which take into account public health risks and social and economic impacts, and the revisions in the law that will require that the health portion of the criteria document be prepared by an independent scientific group. We followed very closely what has happened with them and found out that the selectivity that they have done with the individuals has caused a great deal of confusion.

Mr. **Dunn**. Mr. Chairman, if I might add, we have that independent review group at EPA. One of the problems is they don't have the wherewithall to implement their recommendations at EPA. That independent group already exists. The problem is, EPA doesn't listen to their recommendations.

Mr. **Flacke**. That is correct.

Mr. **Dunn**. That is what I am talking about. A recommendation from you that says not only does EPA have to listen to the review groups, but that EPA has to incorporate the group's recommendations.

Mr. **Flacke**. It should be submitted to them beforehand.

Rather than go over these, Mr. Chairman, we have them outlined on an objective basis; we have submitted them to you, and we hope they will assist you in your endeavor.

Mr. **Scheuer**. When did you submit them to us?

Mr. **Flacke**. Today, sir.

Mr. **Scheuer**. I think it would have been helpful if we had these recommendations in advance so we could have studied them before this hearing. Be that as it may, we will study them, and if we have any further questions on the recommendations, we will submit a joint list of questions to you.

Mr. DUNN. I thank the Chairman.

Mr. SCHEUER. Our distinguished colleague from Rhode Island, Mrs. Schneider.

Mrs. SCHNEIDER. Just picking up on the final note that was mentioned here, it seems quite obvious the Environmental Protection Agency has not been very successful in keeping industry happy, in keeping environmentalists happy, or in keeping States and municipalities happy. I am looking forward to the opportunity when this committee will review exactly what is going on and what the overall plans are of the EPA.

I would like to ask you, Mr. Flacke, the Department of Environmental Conservation, to what degree does that particular department in New York become involved in energy planning?

Mr. FLACKE. The Department has the environmental review of the energy plan, and, as commissioner, I sit on the State Energy Master Planning Board process. We have a separate energy department in the State of New York, and we essentially review those under what is called our State Environmental Quality Review Act.

Mrs. SCHNEIDER. Here we are talking about minimizing the problems of air pollution, acid rain, or whatever, much of which is produced by the generation of various forms of energy. I wonder if your New York Department of Energy has done any investigations going beyond the bandaid approach to looking at alternative approaches toward minimizing this problem; for example, an all-out, full-scale effort toward energy efficiency, to minimize the overall use of energy. Does the State have a comprehensive energy conservation program?

Mr. FLACKE. Yes; it does, and we have done fairly well on that, and I will make available to your office the work that both the Energy Department has done and the group called NYSERDA has done.

Mrs. SCHNEIDER. I would be interested in knowing to what degree there is an effort to rely upon renewable resources within New York State borders. Having 27 powerplants, and being in a position where you are having to make some changes now, at least, I would think the State of New York would be doing a cost-benefit analysis as to the options which would include energy conservation and renewable resources as the highest, most cost-efficient alternative available. I think some of the testimony we had before the Committee on Science and Technology, such as that by Dr. Ellis Cowling, who gave testimony on acid rain research, presented many useful recommendations, one of which was immediately to cut down on consumption of energy. That is something overlooked by many municipalities. There is more of an effort to add scrubbers and to complain about the costs.

Mr. SCHEUER. I think nationally we have had an insufficient concentration on energy conservation. Curiously enough, the American people have responded in a way that I think has astonished all of us. It may be that these marketplace forces are pretty powerful inducements as prices of all types of energy go up. Market forces, themselves, have more of an impact than you and I would have thought perhaps a year or two ago. There has been a remarkable energy conservation, not a program, because we really don't have a national program that is worth a hill of beans.

Mrs. **Schneider**. I think if we had a little bit of leadership in a program, though, we would then really be surprised at how much we might be able to eliminate some of our consumption.

Mr. **Scheuer**. I agree.

Mrs. **Schneider**. One of the other concerns of the Science and Technology Committee is making available technological information to various municipalities.

Mr. Barnes, I would like your comments on this, too. I think that oftentimes different States are not aware that there are such technologies, for example, such as fluidized bed boiler reactors, such as some of the other technologies you were mentioning.

How do you go about seeking out alternatives to the coal-burning process, or what did the State of New York do in first looking for technological fixes?

Mr. **Flacke**. We used a quasi-public corporation called New York State Energy Research and Development Administration, which was a combination of utility money and State money, to try and leverage that by using Federal grant money in investing in the various types of areas—conservation, wind, solar, various types of systems with the public service corporation.

That would essentially allow us to solve what you would call the need in the State—the proper mix—and to come up with a long-range energy master plan.

Our specific problem, however, is meeting our immediate needs and the ability to convert and the ability to get the proper utility mix in fuels seems to now depend on two things: continuation of oil or the rapid conversion to coal.

Fluidized bed is not far enough along for us to use. The ability for us to use scrubbers in New York State, and even Massachusetts and New Jersey and the surrounding areas, is very difficult because the people that developed the scrubber strategy very cautiously said, "Well, we will take all the limestone that is a by-product of it and you can put it someplace," but the someplace never did develop, and we don't have any place to put the refuse that is developed from that.

Mrs. **Schneider**. You have the same problem, of course, with any kind of coal-burning process, but the final product from fluidized bed boilers' reactors is to be used as fertilizers.

Mr. **Flacke**. That is a process where technology is moving along.

Mrs. **Schneider**. One of my concerns is we have all of these terrific technologies floating around, but we don't see them much in use. Do you think the Federal Government has a role, in general, rating the information about these technologies, Mr. Barnes?

Mr. **Barnes**. I really do think they have a role. I would say one of the problems has been in the last few years not so much getting the information out, because EPA has done a relatively good job about getting information out on various processes being developed.

In the case of technologies that look somewhat better, we haven't moved as a priority to prove the technologies on a commercial scale. That is the first problem.

The second problem is without a kind of legal requirement that people reduce their emissions, there is not any real economic incentive from the individual utility point of view to adopt these technologies.

When you couple those facts with the normal inclination of all of us toward inertia—you know we tend to want to stay in the place we are, often, instead of looking out to other areas, because it is more comfortable to stay where we are. You have, I think, a good idea of why the problem still exists like it does.

In a sense, this whole air pollution acid rain problem we are talking about is an example of what some environmentalists call the tragedy of the commons. In a sense, air is a common resource. It is like fish out in the ocean or something like that. And, as we are finding in lots of areas of common resources, unless there is a political agreement by all the users of the common resource as to how to protect it and utilize it efficiently, it is not in the individual self-interest—not the individual economic self-interest, of any player, whether it is a municipality, a utility, or whatever, to take the steps to adopt the new technologies that will make it better for everybody else.

It requires a kind of complete solution.

So I think there is a definite Federal role there. I think, based on what we are seeing out of the early suggested cuts in EPA, again, another big area they have been reduced in is information—putting out information to the public and to industries generally about a whole range of their activities. So we would very much hope that that could be reversed.

Mrs. SCHNEIDER. Thank you very much.

Thank you, Mr. Chairman.

Mr. SCHEUER. Congressman Gregg, have you any further questions?

We are running behind. We have two more witnesses. We do have some additional questions that we are going to ask you, but we will submit them in writing, and we will hold the record open for your answers to those questions, as well as some of the other information we have asked you for.

We thank you very much for your testimony, for your patience, and for your very forthcoming remarks. We are very grateful to you.

STATEMENT OF DR. A. H. ROSENFELD, PROFESSOR OF PHYSICS, LAWRENCE BERKELEY LABORATORIES, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIF.

Mr. SCHEUER. Dr. Rosenfeld, as you know, your testimony will be printed in full in the record, and I suggest you chat with us for 10 or 12 minutes and give us highlights of your testimony, plus any remarks you have about anything you have heard—either the testimony of the other witnesses, or comments you have heard from me and my colleagues.

After your remarks, I am sure we will have some questions for you.

Dr. ROSENFELD. I will first tell you who I am, and then I will, in fact, make a couple of remarks about the relationship between this new field and the well-recognized problem of acid rain, and then I will summarize my testimony and show you a few transparencies.

First of all, I should say I am a physics professor at the University of California at Berkeley.

The reason I am here is that on the U.C. Berkeley campus is the Lawrence Berkeley Laboratory, run by DOE, and that is the lead laboratory for research in the country, as far as DOE is concerned, on air quality.

In fact, we do about all the research on indoor air quality.

The principal investigator for that program, Craig Hollowell, should be talking to you, but he had a conflict with a big meeting in New York today, held by the New York Academy of Medicine, and so he sent me.

I am responsible for the overall program, but I am not as much of an expert in indoor air quality.

I would like to make a couple of general remarks. The first one is that indoor air quality is probably turning out to be a problem for the health of Americans which is as important, I would guess more important, than outdoor air quality.

That wasn't recognized until recently, I think for a simple reason, and that is that you can see, or expect to see, long distances through outdoor air. If you look down the street and can't see the Washington Monument, you know something is wrong.

If you look in a lake and you find the fish are dead, you know something is wrong.

Indoors you only expect to see 20 feet, and you don't see a lot of pollution, but few think about it. Indoor air is just as dirty as outdoor air, with whatever you have contributed yourself, which is usually quite a mess.

Mr. **Scheuer**. What do we contribute?

Dr. **Rosenfeld**. I will get to that in some detail in a minute.

It is now becoming fairly clear, just to get your attention, that something like a half or maybe more of all lung cancer among nonsmokers comes from radon gas in our homes. These are nontrivial problems.

Another comment to follow along with the acid rain problem is, we apply good news financially, as opposed to the acid rain problem. As acid rain will have to be fixed, I don't know what it will cost, but it will probably cost a quarter of a billion dollars for every coal plant, and there are 100 coal plants, and that is like $25 billion to clean it up.

On the other hand, indoor air quality is something we know—we are close to solving, and we can save money. In the case of indoor air quality it has come into focus because we want to cut down the fresh air which blows through homes. When we do that, we find we have problems, but they are not expensive problems.

We are, in fact, on our way to saving a lot of money. We can probably save enough money with indoor air quality programs to pay for the acid rain program, and so maybe it isn't quite as dramatic because it doesn't have brown forests, but it is more lucrative.

Mr. **Scheuer**. I take it you are going to describe the kind of programs you have in mind.

Dr. **Rosenfeld.** Yes. I am going to start talking now about my real interest.

Basically, I am going to confine my attention to homes. I am going to start off by saying that conventionally throughout the western world, until recently the way we built a home is with a lot of cracks in it, and we rely on the wind to blow fresh air into those homes, and, on the average, an existing home in the United States has its air changed by the wind and by what is called stack effect, about once every 1 or 1½ hours. In the stack process, you heat the air in the house, which is then lighter than the air outside and floats up through any holes it can find. The typical house has about 2 square feet of cracks in it, and that contributes to a large flow of air.

Mr. **Scheuer.** In other words, if you add up all the cracks in a typical home, it would equal a hole—

Mr. **Rosenfeld.** Somewhere between 1 and 2 square feet. It is surprising to many people. We measure that easily. We put tracer gas into a house, and you see how long it takes to dilute, and in an hour it is all gone.

In the old days when fuel didn't cost anything, that was great. The universal solution to pollution is dilution, but when that costs money, then you start to worry about it.

The first example of this, I guess, were the Swedes. Oil has been expensive in Sweden for some time, and in 1975, the Swedes decided they were going to require that all new houses be built much more tightly, and when I say tightly, I mean air-tightly, so that all those Swedish houses had an air change of about three-quarters per hour.

The Swedes said they would build very carefully, with less than three-tenths of an air change per hour by law and, if necessary, they would put in mechanical ventilation through a heat exchanger to give fresh air, but in a controlled way.

When they did that, they all of a sudden found they had better start surveying for indoor air quality, and they found that the radon levels were unacceptable. They found the organics from all sorts of glues were unacceptable.

Let me give you an example of how easy it is to fix things once you start marketing them: The largest selling commercial glue in the world is some resin which is made out of ureaformaldehyde foam. If it is properly cured, not very much, although always some; if it is poorly cured, a lot.

The largest exporters of furniture into Sweden were the Poles, who made a lot of plywood and a lot of plywood furniture, and that stuff was a disaster.

The Swedes found very, very soon, as soon as they started monitoring, that they had simply to prohibit the import of Polish furniture and wall materials, and the Poles got their act together, which only took a few months, and now everything is OK again, but it takes some governmental action, and it is hard to see industry taking care of that.

Mr. **Scheuer.** Is our own furniture manufacturing industry using these chemicals?

Dr. **Rosenfeld.** Absolutely. My guess is they could switch to glues that are perfectly safe for another 5 or 10 percent of the cost of the glue, which isn't a lot in the cost of furniture, but they are not going to do that until we learn to monitor such problems and get organized.

Another thing the Swedes found was that certain concrete, which was simply made from bad mountains, was radioactive, and they had to prohibit the manufacture of concrete from certain quarries. That wasn't expensive, but it had to be done. Gradually over the last few years, the problem is getting understood, and it is becoming possible to build low infiltration houses. The Swedes are saving a lot of money.

Mr. **Scheuer**. It is possible?

Dr. **Rosenfeld**. It is perfectly possible to do it. The problem is to monitor and make sure that nobody is getting an overdose of radon and formaldehyde, et cetera.

Mr. **Scheuer**. Is it a simple matter economically to remedy that problem in existing homes?

Dr. **Rosenfeld**. Yes. Let me say exactly how that is done.

Starting maybe 20 years ago—I am not exactly sure when insulation came in—it was soon discovered that you have to put inside of the insulation a film of plastic, which is called a vapor barrier. If you don't do that, what happens is all the water vapor in your house diffuses out through the insulation and by the time it gets out, the insulation is very cold, condenses, and drips, and the insulation doesn't work. So I am told the vapor barrier is an essential, an accepted part of the house It is 5-mil plastic. It is no problem.

Why are houses loose, then? Well, houses are loose only because the contractor is trying to save money for the homeowner, and they put the insulation barrier in place, and then the electrical installer comes and he sticks his foot through the vapor barrier in the attic, and he drills a big hole to let the plumbing through; and some other man is hired, and he puts in a recessed light fixture and tears a big hole in the insulation barrier, and so on.

All it takes is a little care. Perhaps it adds maybe $100 worth of care to a house to leave it completely airtight.

That is fine except you can't live in the house—in an airtight house. It will smell bad, mold will go under the carpet; radon will be off-scale, and so on; so you need mechanical ventilation.

If you put in mechanical ventilation, you have to pay for all the cold air you are bringing in because you are going to have to heat it; so you haven't done anything, so you need mechanical ventilation through what is called the heat exchanger, and I am going to show you a picture of that in a minute, but they don't cost very much. We are gradually learning to make them in this country. They are required by law in many countries.

Mr. **Scheuer**. Which countries?

Dr. **Rosenfeld**. In Scandinavia they are absolutely required by law. In Japan they are selling like hotcakes, and the first American manufacturer has just decided to start making one; so they will soon become available.

Now, I am going to go through the slides and transparencies and show you pictures of these things, but let me first give you the economics.

If you take the regular rate at which air drifts through your house, and you heat that air every hour or hour-and-a-half all winter in an average American house, it costs you on the average $200 to do that. If you do it through a heat exchanger, you get it down to $50, or something like that. You can save about $150 a year. That is certainly the way to go.

Now, I have to make one point about public health, and that is there is a difference between what is called retrofitting existing houses and the problems of new houses. Ninety-nine percent of the existing houses, your house, any house, let's assume has one air change an hour—you want to save a fuel bill—you can go plug up some of the cracks.

We are experts at finding the cracks. We pressurize the house and look for smoke going through the cracks, and we find in about a man-day's work we can cut the air change rate by about 30 percent. That is economically very lucrative. It corresponds to saving gasoline or fuel oil at something like 20 cents a gallon, but people are a little scared to do it because they are saying, "What am I doing to the indoor air quality?"

In most existing houses we find out that there are no serious pollution problems, and therefore it is perfectly possible to cut the fresh air by 30 percent, and you don't have any appreciable worry, and so it is fine.

The trouble is that when we make surveys throughout the country, we find that like 1 to 5 percent of the houses really have serious problems, particularly radon.

The obvious solution to that is to fix those 5 percent of the houses, but in order to do that we have to have some sort of Government programs to make surveys and find out where are the pockets of radon.

Mr. **Scheuer**. What houses have pockets of radon?

Dr. **Rosenfeld**. That is right. In fact, we found one fairly bad pocket of radon in a suburb of Washington, D.C., or at least Mount Airy, Md., which is about 30 miles from here, where I will show you that most of the houses we looked at had serious problems.

Mr. **Scheuer**. Now was that due to something intrinsic to those houses?

Dr. **Rosenfeld**. It is due to uranium in the soil, which means that it is due to just a natural geologic problem which exists in certain States, but we don't have it mapped yet. The funds to do that sort of thing have just been cut in half by the Reagan administration.

So we are held up on an important retrofit program which would save a lot of energy because we cannot in good faith tell everybody "retrofit your house" because we are not sure where the few percent of offending areas are. That is the existing-homes problem.

In new homes it is really quite different. We know that it pays to build them tight and put in mechanical ventilation, and there I think what we need is a different sort of monitoring, because as soon as you become dependent on mechanical ventilation, then you know any system is going to be broken part of the time, so if you rely on homes where you have mechanical ventilation, you can assume for the first few years 20 percent will not be working; so you need some way to have some sort of service to inspect to be sure they are working properly and nothing like that is in place, and, again, that worries people.

That is the general problem except to say if we can get new homes tight and old homes retrofitted, we will save probably $6 billion to $8 billion a year. That program is being held up because of small uncertainties in indoor air quality research which costs maybe $6 million to $8 million a year.

The factor of 1,000 is a bad deal, and instead of calling it penny-wise and pound-foolish, I guess I would call it penny-wise and hundred-pound foolish, and yet those research programs are, in fact, being cut.

Now, I would like to show you a few transparencies.

These pictures are in my testimony, though I will show them in a slightly different order. The purpose of the first one is to show you what we have learned about the problem of radon in homes.

Now, radon is one of a theme of elements that come from the decay of uranium. Uranium is a very wide-ranging element. It exists in almost all rocks, almost all building material. It decays over millions of years to lead, and on the way there is one atom, radon, which is a mobile gas that doesn't stay put. All the other decay products stay where they are made because they are chemically active.

Radon can diffuse distances through types of soil and concrete and gets out into the air. There it decays into other radioactive elements. You breathe those elements; they stick to your lungs for a few days, during which time they preradiate your lungs. So radon produces lung cancer. That is extremely well known, unfortunately, because during the 1950's many uranium miners got overdoses from radon and are now dying off quite rapidly from lung cancer; so, unfortunately, we know the morbidity quite well. The biggest uncertainty in the whole problem is what the smoking problems of miners were because the two effects are synergistic, and if you smoke, you are more susceptible to radon than if you don't.

Apart from that uncertainty, we know quite well what the problem is.

Now, radon seeps up from the land. If you measure radon over the open sea, you find none. If you measure over fields, you find a little bit. A third of what I am going to call a unit, and if you measure it in a house, you find instead a few units.

What is a unit? Well, first of all, let me say I have just drawn a picture here of radon coming in through the basements, the concrete, coming up through drains and other places. It is also worse in the bottom of the house, and then it seeps up into the living space.

Mr. SCHEUER. You are saying it is always worse in the basement?

Dr. ROSENFELD. As it comes up mainly from the soil, then the basement will see most of it, particularly if it is a closed, inhabited basement, where there is not a big flow of air. If it is a crawl space, you don't have to worry very much. It depends a lot on the house.

I have, in fact, a plot here, which I think is not in the testimony, which shows what we always find about radon concentrations.

The standard unit, which I have called one, is in some units which you don't care about, called nanocuries per cubic meter, but roughly it is equivalent to smoking one cigarette a day in terms of risk of lung cancer.

If you look at typical houses in Austria or New York, you find it to be less than one. It is probably safe to say that the average house has a risk of lung cancer equivalent to smoking one or less than one cigarette a day.

Mr. SCHEUER. You exclude cigar smoking.

Dr. ROSENFELD. I make no comment about cigar smoking. I think I would exclude them because you don't inhale them, I believe.

On the other hand, if you look at typical houses which are being made today, which have only, say, a quarter of the rate, then the radon doesn't get diluted as fast. It drifts up, stays in the house for a while; eventually it goes up into the stratosphere and gets diluted.

If it is kept in place for a day, or 4 or 5 hours, then it is more concentrated. Typical energy-efficient homes around here run to 10 units, and that is where we started monitoring.

So we concocted a trailer, the one which is in the first page of my testimony, and we offered to go around to buildings and energy-efficient homes and monitor the indoor air quality, including radon.

Mr. SCHEUER. Is that service commercially available?

Dr. ROSENFELD. No; there is no such service commercially available. I am sure in a few years it will be. I can talk at the end about why I think States should provide such a service. But right now, if you are worried, it is tough. There is nothing you can do. I think that is a shame.

Mrs. SCHNEIDER. Might you provide the members of this committee with a copy of that photograph also at some point in the future?

Dr. ROSENFELD. This is included in my prepared testimony.

Mrs. SCHNEIDER. Thank you.

Mr. SCHEUER. How about the building we are in now, the Rayburn Building, which is constructed of stone. Would there likely be a greater concentration of radon here?

Dr. ROSENFELD. If there were no mechanical ventilation in this building, then there would be a lot of radon. Now, there is mechanical ventilation and it probably is adequate.

Actually, privately, off the record, I have been wishing I could measure the radon in the Rayburn Building for some time. But I haven't gotten around to it.

Mr. SCHEUER. Let's not keep this off the record. Let's keep this on the record.

Dr. ROSENFELD. It should be done. I will tell you where it turns out to be interesting. Where you get to being economical about energy, in a standard office building, you tend to turn off the fans all weekend. Then, of course, there is nobody there and it is fine. For the first few hours on Monday morning when you just turn the fans back on again, there is probably a problem. That is one of the things we are investigating.

Mr. SCHEUER. You are recommending that office workers not turn on the fans?

Dr. ROSENFELD. That is roughly the message.

Mr. SCHEUER. I am sure millions of Americans would be delighted to follow that advice.

Dr. **Rosenfeld**. Before I get on to Mount Airy, I would like to say the solution, which is extremely cheap, is you want to get fresh air without paying for it. This is further back in my testimony. The idea is 50 years old except recently cleverly improved by the Japanese.

The idea is that you want to consider this to be the outside of the building, this to be the inside. You have a lot of nice hot air which you want to get rid of and be replaced by outside air. If you let those two air currents flow past one another separated by only a thin layer of paper or plastic, the heat will be exchanged and you can get as much fresh air as you want, preheated by the exhaust air. That is a good trick. It is called a heat exchanger and we should start building that into houses. I will show you a picture of one in a moment. They are very cheap.

Mr. **Scheuer**. Since we only added about 1 percent to our housing inventory every year, is it going to take us a generation or more to meet this problem head on? The big question is the 99 percent of the housing that presently exists.

Dr. **Rosenfeld**. Absolutely. You remember my point when I was trying to make a summary is that I think we can show that about 95 percent of existing houses are perfectly OK. All we have to do is reassure people by making simple measurements. About 5 to 1 percent—we don't know—do require remedial action and are probably unsafe now, so you certainly shouldn't tighten them until you provide remedial action. Then in new houses, one wants to go ahead with this.

Mr. **Scheuer**. What are the characteristis of the existing housing inventory that would indicate whether there is a high risk of carrying this radon?

Dr. **Rosenfeld**. We believe they will all come in clumps. They will come in clumps called let's say, Mount Airy, Md., Harrisburg, Rockford, Ill. But we need to go out and find those clumps and then provide remedial action for them. Those houses will in fact probably require very large heat exchangers so that we can make them safe.

Mr. **Scheuer**. This is all due to the basic underlying quality of the soil and the foundation?

Mr. **Rosenfeld**. Right, and occcasional bad luck where somebody manufactured concrete from a quarry which had the same difficulty, plus some organics. There would be spots but we don't expect it to be a chronic problem. Just to show you what a simple device it is, that is a photograph of a Japanese heat exchanger made by Mitsuibishi Co., which you can buy in the United States for about $140. This sits in the window so there is no installation cost and will give you half an air change of fresh air preheated.

Mr. **Scheuer**. That would sit in the window, where?

Dr. **Rosenfeld**. Anywhere in your house.

Mr. **Scheuer**. It could be in the basement?

Dr. **Rosenfeld**. It could be in the basement. One of the beauties of the way we heat houses in most of the country is that we have a furnace and a furnace fan. So once we introduce fresh air into the house the furnace fan in the winter will take care of swirling the air around the house 10 times an hour, so that if you open a window in a house, for example, you get fresh air all over the house as long as the furnace is on and you don't have to connect the window to the furnace through a duct. Nobody ever does that.

This has the same nice property. Now, if you are building the house, you might buy a unit which sits in the wall and put it near the furnace return. But there is no complicated problem. In fact, the Canadians are very embarrassed because when they started doing this, some of my friends started wasting a lot of money connecting these units to the furnace until some contractor pointed out to them that they were absolutely nutty. There was no need to do that. Then they dropped it.

Mr. SCHEUER. OK.

Dr. ROSENFELD. Now here is how you put the two together. This is Mount Airy, Md., Carroll County, Md. I think this is rather dramatic because it has two stories built into it and it is figure 3 on your testimony. It is a plot of how we experimented with this house at the request of the National Association for Homebuilders over about a month of October 1979.

What is dramatic about this house is first of all, that it was built as the great pride and joy of the National Association of Homebuilders who wanted to show how to build an energy efficient home. Then they got a little scared about radon so they called us and asked us to measure it. So we did and it was terrible. Then we came back and loaned them a heat exchanger. In fact, it is one of the heat exchangers whose picture I have shown you.

Now, this scale labeled zero to 10 to 20 to 30 is my unit of roughly 30 cigarettes a day. You can see that in this home—what happened was we aired out the house and closed the windows. The radon started to climb. Over a period of about 8 hours it climbed up to a perfectly unacceptable level of 30 cigarettes per day per man, woman and child living in the home.

We then turned on the heat exchanger and with great relief, it comes down just as it is supposed to. However, notice that it didn't come down to one cigarette a day, it came only down about five. We turned it to its second speed, it came down a little further. We turned it off and it went back up to about 25, meaning that there was a little more wind that day and a little more natural infiltration. We turned it to absolutely full speed and finally got it down to one.

In one sense, that was a great victory because we were at this stage expending maybe 80 watts of fan power in this little heat exchanger to be saving something like 8,000 watts of heat. So economically, it is very sound. But nevertheless, what bothers us as a group was that at half an air change per hour, we weren't down safe. So on the one hand this is a victory. On the other hand, we decided we better go out and do some more surveying.

So we made a contract with Geomet, which is a Maryland consulting company. We lent them some of our equipment and said please go measure 60 conventional houses in Mount Airy across the street. What sort of shape are we in? Well, we are in bad shape. This report is out now—figure 4 of my testimony.

I also quoted from the full report. Each red line is at a pack a day. Now, this is a survey of the other 50 homes in Mount Airy. This is the radon levels in the basement, but some of them are inhabited basements, conditioned space.

This is the radon levels on the main floor. It is a distribution. That is of the 59 houses—let's look at the basement—25 percent of them were fairly low. But this is a tail out here of about 10 percent, which is over a pack a day, in ordinary houses. One of them is at 66. Several are over 20.

On the main floor, again, most of them are under 10, although I am not sure that under 10 is exactly safe. And one or two of them are at 25. We concluded from this that we are going to find such things, that it is then the responsibility of the State or local government to buy monitoring equipment and measure everybody but that we will have led the way with research funds pointing out where these difficulties are.

Once people feel that they are being looked after and that there is no chance that they have a radiocative house before they start, then we feel they will be much more confident about going out and making their ordinary houses air tight and save a lot of money. So that is the basic problem with radon. There is a figure in my testimony which sort of summarizes what radon does do today?

I am only going to point at the bottom line which says if you take the lung cancer data, you correct a little bit for the fact that cigarettes are supposed to be better today and a few people smoke a little less, you come out with a guess that there are about 10,000 lung cancers per year which all of us are enduring because we choose to live in homes. There is no way around it. That is the background. But we don't want to make that a little bit worse without getting the really bad houses and improving health and safety by fixing those up.

Mr. **Scheuer**. Do we have this table?

Dr. **Rosenfeld**. Yes.

Mr. **Scheuer**. What do you mean by radon daughter exposures?

Dr. **Rosenfeld**. The radon itself only decays—I don't want to give you a lot of nuclear physics but radon decays. Usually when it is not in your lungs—I told you radon is a noble gas, it doesn't stick to anything. Even if you breathe it in you are going to breathe it back out again. The trouble is it decays into a couple of shortlived nuclei. A few minutes after they are made they are radioactive.

If during that time—because they are floating around in the air, you breathe them in, they stick in your lungs and it is those so-called daughters which actually do the trouble. So inevitably associated with radon are these two radiocative daughters and they are the bad guys. But it is easier to measure radon. Does that answer you?

Mr. **Scheuer**. Yes.

Dr. **Rosenfeld**. Now, I am changing the subject a little bit to talk about the other place where we have to be careful. I told you that a very popular glue is ureaformaldahyde resin, but there are an awful lot of consumer products these days that are going to be made up of a lot of chemicals. That is getting to be a pretty bothersome problem. So I want to show you one transparency which is not in my testimony.

I will show you the same thing quantitatively. It is just a little easier to make a contrast here. Let me say exactly what this is. We bought some new office trailers and put them in front of our building about 6 months ago because our program was still expanding.

We needed more office space. So we got the idea that we would measure the level of organics like formaldehyde—which is bad for you and eventually a carcinogen—in new office trailers, standard trailers.

So first, we measured the organics with what is called the chromatogram without air—this one—with one controlled spot and found a few peaks of what you might expect because automobiles are driving by, there are refineries in the bay area, et cetera. That is the sort of thing the Clean Air Act is supposed to worry about, keeping that tolerant.

Let's look inside these same new trailers, this area with whatever exudes from the plywood, the carpeting on the floor, new furniture and stuff. It is 100 times worse. That is what every new office building looks like and nobody seems to be concerned with it very much because it is a new field and we are barely developing equipment to measure cheaply.

As I said, I am a little disgusted because our funds are now cut in half. The actual picture in the testimony shows this in a more quantitative way. This is a few peaks of organics taken on the roof of a new office building in San Francisco, the sort of thing the Clean Air Act, I repeat, is trying to keep at reasonable levels.

Let's go in the same office building which is maybe a 1-year-old building in San Francisco with the same mass chromatogram adjusted to the same scale and that is what you find. Every single one of those peaks may be a carcinogen. Moreover, what is interesting is that there are probably synergistic effects in which combinations of the two are bad and those measurements have never been done before because all the OSHA standards are for individual chemicals and we have a brand new field here which should be looked into.

Mr. **Scheuer**. What would the proper agency of Government be to investigate those synergistic effects?

Dr. **Rosenfeld**. I am a little out of my field. There are so many different agencies that I am going to hedge a little bit and simply say that it is still in the research field. I will make, however, a bitter remark. That is that when our program got badly cut and we were looking around for friendly agencies, we made a number of calls to labs with which we collaborate, that is, within EPS, Center for Disease Control in Atlanta, and so on. What we found is that all these programs have been cut to about in half. So there is nobody who is able to take in, at least, our unwashed linen.

But I don't have a good feeling for what is a very broad field. I do want to make the following point. I don't want to over-do it although all those spikes are measurable. Here are a few organics that we have measured that correspond to that figure. I have tried to be careful over here to put the OSHA limits in parts per billion, and the actual numbers that we measure in parts per billion.

You will see that the individual spikes, although quite measurable, are typically a factor of a hundred below OSHA standards. However, I still want to make the point that we don't know about the synergism, and although each one is probably 100 below OSHA, they are like 100 spikes. So it is not clear that we are in such good shape. It is certainly clear that it is something that we should worry about.

Now, my last remark, and then I will quit, is that what there is a desperate need for besides more work on buildings, clearly more work on the risk to animals and humans, is just good instrumentation. I think that the major contribution of the DOE labs has been to try to develop portable instrumentation. When we got into this field 5 years ago, if you wanted to measure radon, you had to buy $3,000 worth of equipment and find a C-power source and plug it in and have a technician stand there for several hours trying to figure out how to do it.

This is how we measure radon today. We leave this with Mrs. Smith. We take it to the wall, we uncap it. Mrs. Smith only has to take it down a week later, put the cap on and mail it to the lab. Once we get into shape like this we will be able to do decent surveys at reasonable costs.

Mr. SCHEUER. Excuse me. Does Mrs. Smith only have to have one of those for the whole house or does she have to have them for each floor?

Dr. ROSENFELD. Of course, that depends a little bit on the level of research. If we are trying to decide whether the basement is worse then the second floor, then at first as a research project, Mrs. Smith might want two. Also, this is for a single chemical. Actually, in homes we are interested in, about five—combustion products, radon, organics, and maybe oxide of sulfur. So Mrs. Smith might need four but it is still not a big deal.

The point I guess I would like to make is that at some stage of the game this will be a profitable field for industry. But I believe that if we don't take some lead, if the research organization and academic institutions don't have enough resources to lead the field, we will waste 5 or 10 years. Better that we go ahead and get the field established as fast as we can with our resources, and that will just advance jobs for industry and public health and everything.

I don't feel we are doing anybody any harm by pushing the field a little bit. I don't think we are hurting the marketplace. I feel in fact that we are helping it. So I believe that the Government program doesn't really have to be terribly expensive in the monitoring field. I think States and counties and so on will quickly learn if you give them the tools. But what we absolutely have to do is to provide the portable monitors, a few good vans, maybe one per State, which can run around and measure everything, and provide the necessary statistics.

If we provide that infrastructure, then I think industry and local government will probably take off. But they can't do it now because they don't know what to do. I think that is the major point I was going to make. I will be glad to answer any questions.

[The prepared statement of Dr. Rosenfeld follows:]

Measurement and Control of Indoor Air Quality in Existing and New Homes

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National Academy of Sciences.

Testimony to be presented by A.H. Rosenfeld

Before the Subcommittees on
Energy Development and Applications
and
Natural Resources, Agriculture Research, and Environment
of the
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

May 28, 1981

May 26, 1981

Mr. Chairman, thank you for the opportunity of appearing before you today. My colleague, Dr. Craig D. Hollowell, regrets that he cannot appear as invited, he is speaking at a meeting on Indoor Air Quality in New York City.

I am a Professor of Physics at the University of California at Berkeley. Dr. Hollowell and I are both heavily involved in research in Energy-Efficient Buildings and Indoor-Air-Quality at Lawrence Berkeley Laboratory (LBL). Dr. Hollowell is a member of two NAS/NRC Committees, one on Indoor Pollutants,[1] and one on Aldehydes,[2] as well as a member of the WHO Working Group on Health Aspects Related to Indoor Air Quality.[3] Our testimony draws from those reports, and from recent testimony which I (Rosenfeld) recently presented to the House Interior Appropriations Committee.[4]

Another relevant document is the Workshop Report on Indoor Air Research Needs, conducted under the sponsorship of the Interagency Research Group on Indoor Air Quality, held December 3-5, 1980, to be released June 1, 1981.

We present a brief summary of current research in indoor air quality in residences, and come to the following conclusions:

- In the vast majority of existing homes, the indoor air quality appears satisfactory, and will not be impaired by reducing the infiltration of outside air by 1/4 "ach" (air changes per hour). By doing so, the occupants will save $50-75 per year in fuel bills, at little risk to their health. See footnote below.

- In a very small percentage of existing homes, the radon level is disturbingly high, mainly because of radon in soil gas. Residents run a risk of lung cancer equivalent to smoking several cigarettes per day while the windows are kept closed. In these homes the sources of radon should be more completely isolated from the home or measures should be taken to refresh the air, such as equipping the home with mechanical ventilation and a heat exchanger. The home can then be retrofit to reduce the infiltration.

- In the case of new homes, we can save energy and money by building them with only 0.1 to 0.3 ach, but the indoor air is more likely to be unacceptable. However, the air change rate can be supplemented with about 0.5 ach of mechanical ventilation through a heat exchanger. In new homes, the concentration of organics, particularly formaldehyde is almost always comparable with health guidelines, particularly when the furnishings are also new. There is need for laboratory experiments to see how long these levels persist.

With even the best current house-doctoring techniques, it is difficult to reduce the infiltration by more than 30%, so there is no danger of making the house very tight.

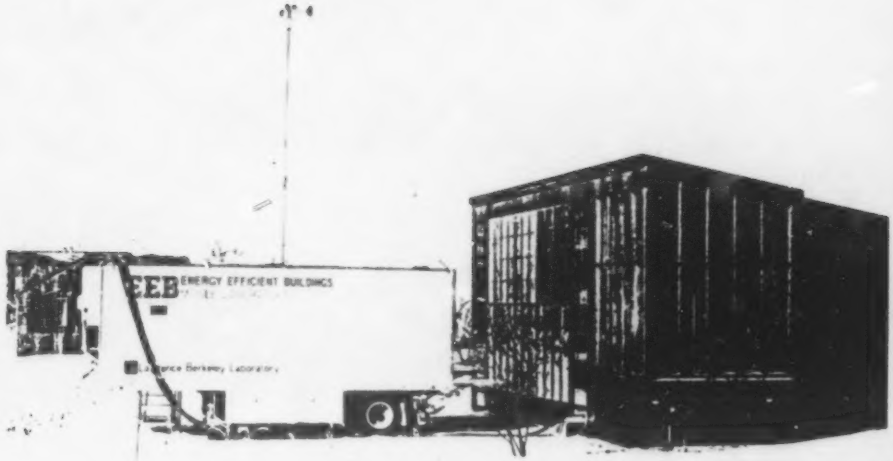

EEB ENERGY EFFICIENT BUILDINGS
Lawrence Berkeley Laboratory

Figure 1. The Energy Efficient Buildings Mobile Laboratory

May 26, 1981

* * * *

In the United States, the natural infiltration of outdoor air causes, on the average, a complete exchange about every 1.5 hours of the 1,000 lbs. of air in the typical house. This is called 2/3 "ach" (air changes/hour). This natural exchange dilutes the indoor pollutants: combustion products from stoves, heaters, and cigarettes; organics outgassing from particle board and furnishings; radon outgassing from soil and building materials; odors, water vapor, etc.

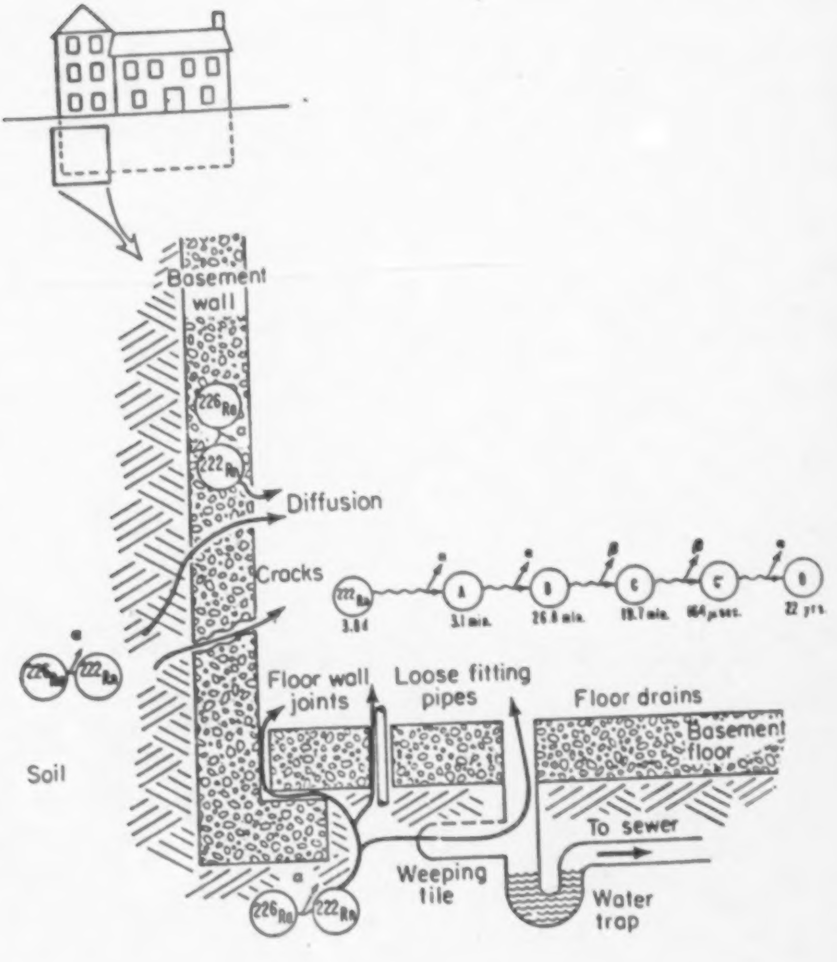
In 1975, in Sweden, a new building code, SBN 75, was passed with the intention of limiting natural infiltration in Swedish homes to 0.2 ach. Additional ventilation, to supply a total of 1/2 ach, was provided by mechanical means. This program was delayed because of problems with indoor air quality. Measurements (some of which could have been made before the code was written) showed that even the accepted 0.5 ach was inadequate for some homes. By inadequate we mean that at 0.5 ach (in Swedish homes) pollutants might build up to undesirable levels. Among them are radon, a radioactive gas whose decay products induce lung cancer, and formaldehyde, an irritant organic chemical.

The Building Ventilation and Indoor Air Quality Program at Lawrence Berkeley Laboratory (LBL) is an extensive program integrating building science and indoor environmental science. Much of this work has been accomplished with the Energy Efficient Buildings Mobile Laboratory illustrated in Figure 1. Some of the research results of this program as well as the general issues of indoor air quality are presented in this text.

Radon

LBL has measured radon gas in houses throughout the United States. Figure 2 illustrates sources of radon in buildings. We introduce Figure 3 to show that we have developed and tested hardware both to detect radon gas and control it effectively. Figure 3 shows the concentration of radon in a home in Mt. Airy, Maryland. The measurements cover two weeks. The radon levels in this house can be compared to other data and health guidelines shown in Figure 3.1. The non-scientific reader can best interpret the vertical scale by using the coarse rule of thumb that continuous exposure to one nCi/m^3 corresponds in lung-cancer risk roughly to smoking one cigarette a day (which doesn't bother most of us), so that the maximum of 30 units corresponds to every man, woman and child in the home smoking 30 cigarettes a day (which is, a much more serious matter). This is in some sense a worst-case analysis, see Note 6.

Exposures of the entire population, even to typically measured indoor concentrations, may cause 2000-20,000 lung cancers in the United States per year. Even more serious is the risk experienced by the several percent of the homes that have much higher concentrations. These would require special control measures.


Basement wall
^{226}Ra
^{222}Rn
Diffusion
Cracks
^{222}Rn
3.8d
A
3.1 min.
B
26.8 min.
C
19.7 min.
C'
164 μsec.
D
22 yrs.
^{226}Ra
^{222}Rn
Soil
Floor wall joints
Loose fitting pipes
Floor drains
Basement floor
To sewer
Weeping tile
Water trap
^{226}Ra
^{222}Rn

XBL 796-1661A

Figure 2. Primary pathways for radon entry in buildings.

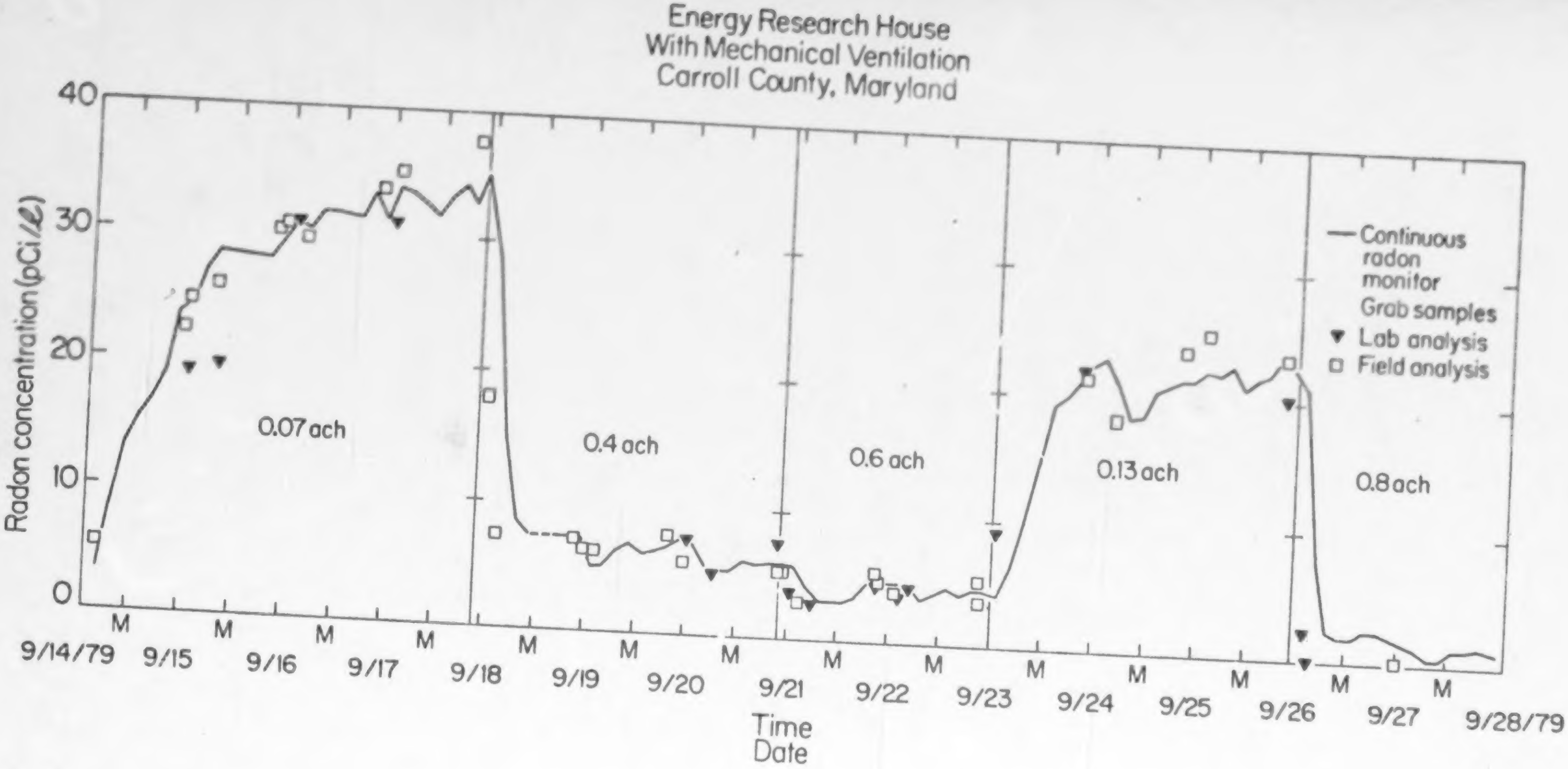
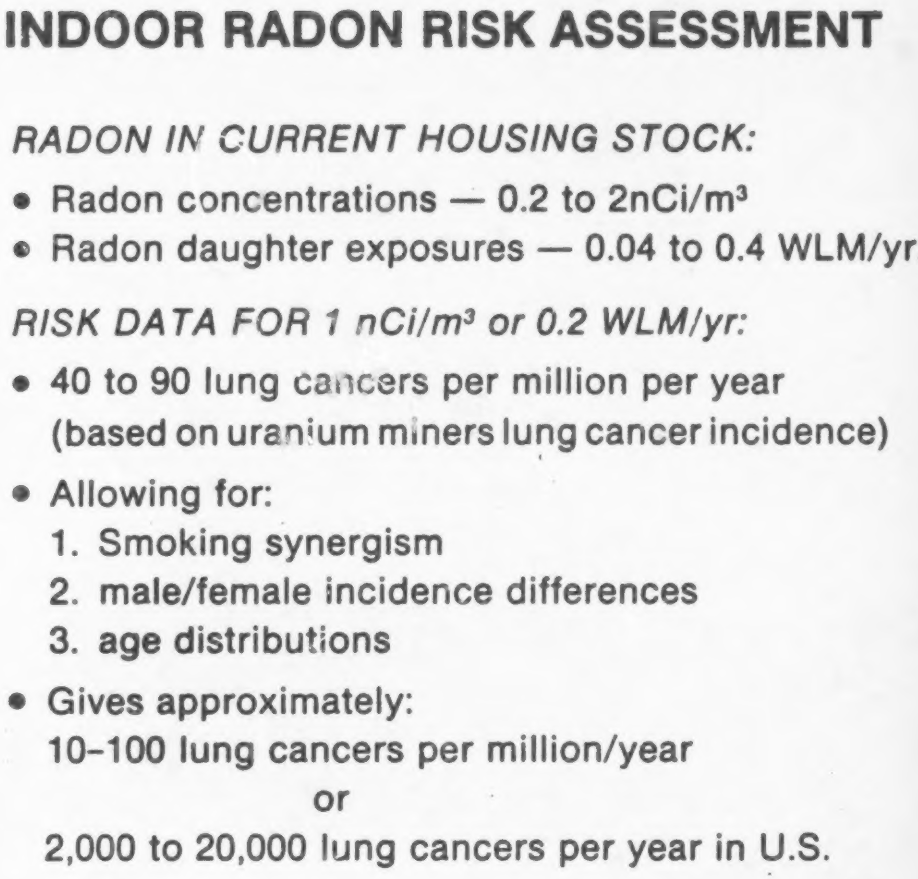


Figure 3. Indoor radon concentrations at various air-exchange rates.

Figure 3.1



INDOOR RADON RISK ASSESSMENT

RADON IN CURRENT HOUSING STOCK:

- Radon concentrations — 0.2 to 2nCi/m^3
- Radon daughter exposures — 0.04 to 0.4 WLM/yr.

RISK DATA FOR 1 nCi/m^3 or 0.2 WLM/yr:

- 40 to 90 lung cancers per million per year (based on uranium miners lung cancer incidence)
- Allowing for:
  1. Smoking synergism
  2. male/female incidence differences
  3. age distributions
- Gives approximately:
  10–100 lung cancers per million/year
  or
  2,000 to 20,000 lung cancers per year in U.S.

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One possible control measure is the supply of additional ventilation air using an air-to-air heat exchanger. In Europe and Japan there is a well established residential heat-exchanger industry. In California, LBL has set up a heat exchanger testing facility and has tested many foreign units. Only in 1980 did a United States manufacturer enter that field for residential units. The home in Mt. Airy was aired out, and then the windows were closed as the experiment began. In Figure 3 we see the radon build up over about one day, and level off at about 30 nCi/m^3 until an air-to-air heat exchanger was turned on. The level promptly dropped to 5 nCi/m^3 for a few days. Then the mechanical-ventilation / heat-exchanger was turned off and the radon rose again. This time the natural infiltration rate was higher (it was windier or colder) and the radon level rose only to 20. Finally the heat exchanger was turned to a higher setting and reduced the radon to relatively safe concentrations. These heat exchangers retail for $250 for window unit to $500 for a central unit, and demand only 50-150 watts of electric power.

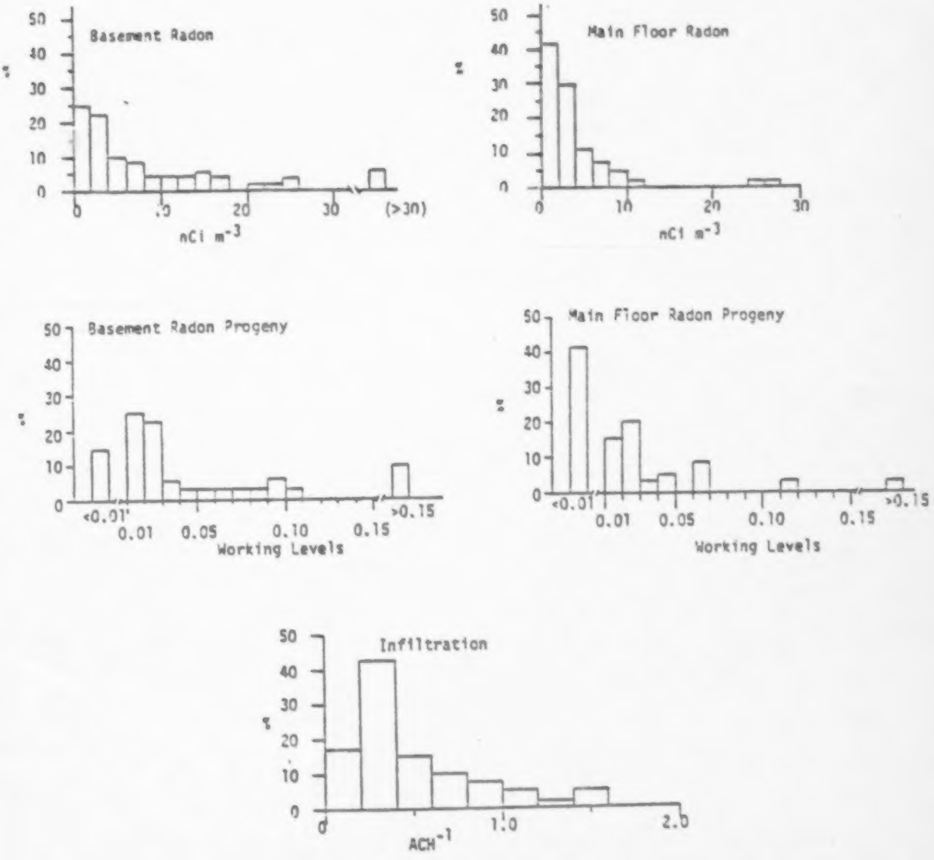
If the radon level in this energy-efficient home dropped only to 5 nCi/m^3 at 0.5 ach, it seemed likely that there was a high concentration of radon in the soil gas in the neighborhood, and that conventional, leaky, homes should be measured also. LBL contracted with Geomet Corp.[5] for a survey of 59 homes in a Maryland suburb of Washington, D.C., and the results of this study are shown in Figure 4. Four of the homes have radon levels of over 10 nCi/m^3 on the main floor (two are 25 nCi/m^3); one basement of a conventional home measured 67 nCi/m^3. On the basis of this spotty evidence, and similar results in Pennsylvania, we worry that perhaps one percent of the homes (with over 2 million occupants) in the United States may have radon levels above 10 nCi/m^3, where remedial action would be indicated.

Organics

In 1978, LBL initiated a project to measure organic pollutants in homes and office buildings. In one home it was determined that the new furniture was a source of formaldehyde at levels which could cause discomfort to occupants. We do not yet know how long it takes for this formaldehyde level to subside, nor have we yet received funds to set up a laboratory to follow outgassing with time.

In the past few years, office workers throughout the country have registered numerous complaints of "bad air." These complaints come most frequently from workers occupying new office buildings with hermetically sealed windows. Although various government agencies have investigated these problems, the etiological agent(s) has frequently remained unidentified. Most often, indoor air quality problems have been remedied by increasing the ventilation rate in the affected area; however, this remedy is in conflict with strategies for reducing energy consumption by lowering ventilation rates. To resolve this conflict, designers and occupants need to be informed about indoor air pollution sources and characteristics so that appropriate (i.e., energy efficient) strategies can be implemented for the prevention, distribution and/or removal of indoor pollutants.

59 Homes in Mt. Airy, Md., surveyed by GEOMET for LBL.
GEOMET Report ES-877, Jan. 14, 1981



Note by A. H. Rosenfeld: on the top two histograms, the unit of 1 nCi/m^3 is the same as the 1 pCi/l in Figure 1, and is roughly equivalent in lung cancer risk to one cigarette per day; 20 is about a pack a day. This is, however, a worst-case analysis by a factor of 2 to 4; see Note 6.

Figure 4. Frequency distributions of radon concentrations and working levels of Rn progeny (basement, main floor) and infiltration for all homes in survey.

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One of the primary contributors to poor indoor air quality in office buildings may be organic contaminants, which have numerous indoor sources: building materials, cleaning products, tobacco smoking, furnishings, common consumer products, and building occupants themselves. To date, however, there has been relatively little research on this topic. LBL began a comprehensive DOE-sponsored research program in collaboration with EPA, CDC, and NIOSH, to characterize indoor air pollution in "complaint" office buildings in FY 1980. However, this research was recently terminated because of the FY 1981 budget rescissions.

Figures 5 and 6 shows comparative gas chromatograms of an indoor air sample and an outdoor air sample taken simultaneously at an office building. Each of the indoor peaks represents a separate organic compound. Indoor levels of several organic compounds were found to be considerably higher than outdoor levels.

Table 1 lists identified compounds for which the indoor concentration was at least five times as great as the outdoor concentration and identifies those compounds for which standards of exposure have been promulgated by the Occupational Safety and Health Administration (OSHA) for the workplace environment. Research had been in progress to quantitatively determine the concentrations of these organic compounds, however, the current state-of-the-art analysis provide only rough estimates. Estimates made in this manner indicated that major indoor organic contaminants were present in concentrations ranging from 1 to 100 ppb; these individual concentrations are all well below existing occupational exposure limits established by OSHA. Note, however, that limits for the general public are typically at least ten times lower than occupational limits.

The potential health hazard from the combined effects of the organic compounds found in these samples cannot be assessed at this time, nor was any single compound present in high enough concentration to be singled out as a health hazard by existing OSHA criteria. On the other hand, it is important to note that those criteria were established for the workplace environment where unusually high exposures to a single compound are encountered. The possibility cannot be overlooked that cumulative exposure to low levels of several organic compounds, or synergistic health effects, may explain the symptoms reported by occupants.

Economics

To assure good indoor air quality, homes should probably have about 0.5-0.8 of an air change per hour (ach) unless there are major sources of indoor pollution. To heat 2/3 ach all winter in a typical home, requires 200 gallon of fuel oil ($250) or 250 therms of gas ($150).

If new homes are built with a carefully installed vapor barrier, natural infiltration is reduced to about 1/10 ach, and can be replaced with mechanical ventilation at a rate, for example of 2/3 ach through a heat exchanger with an effectiveness of about 75%. Figure 7 illustrates the functioning principle of an air-to-air heat exchanger. Such devices retail from $250 for a window model (see Figure 8) to $500 for a central

Figure 5.

Chromatogram of Air Sample Taken Inside a New Office Building

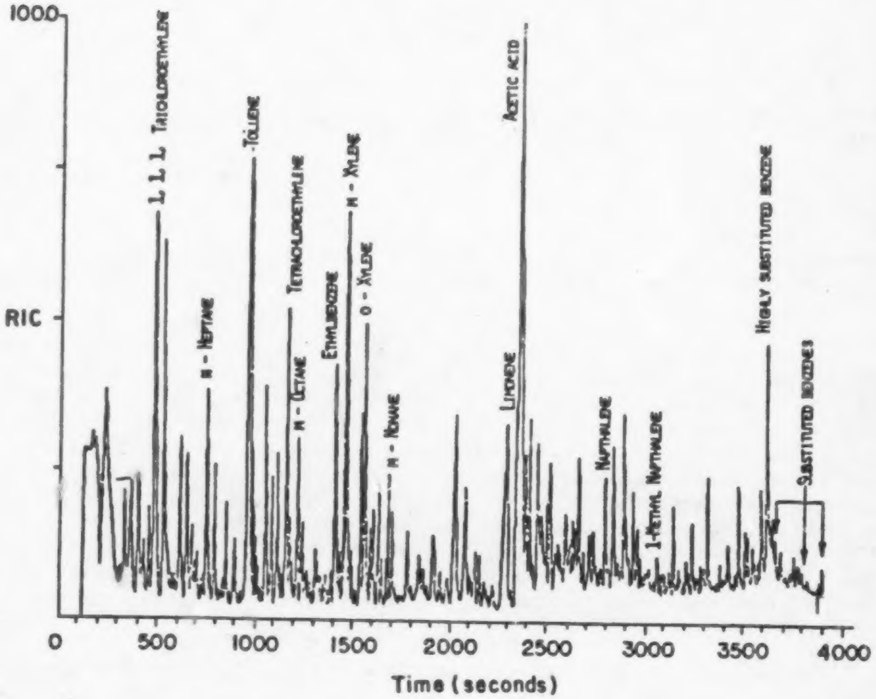
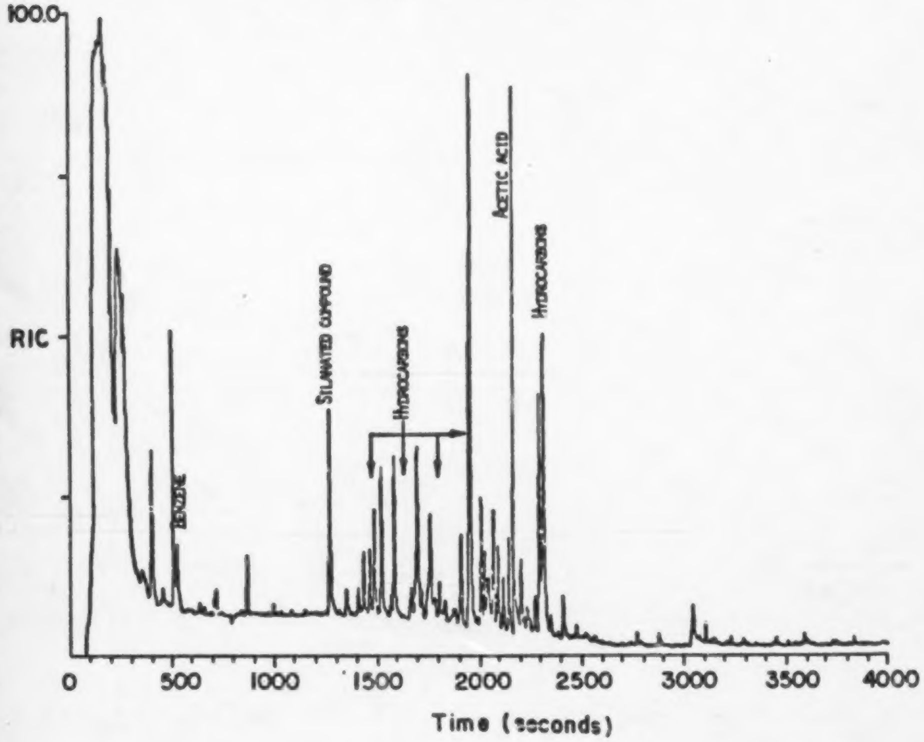


Figure 6.



Chromatogram of Air Sample Taken on the Roof of a New Office Building

Table 1. Organic Compounds Identified in Indoor Air[a]

Compound	Approximate Ratio [Indoor] / [Outdoor]	Approximate Concentration (ppb)	OSHA Limits,[b] and Agency Identifying Compound as Potential Health Hazard	
Hydrocarbons:				
n-heptane	10	20		
n-octane	80	300	500,000	
n-nonane	100	150		
cyclohexane				
hexane				
many other branched aliphatics				
Aromatics:				
benzene	5	25	1,000	EPA
toluene	5	75	200,000	NIOSH
xylenes	15	150	100,000	OSHA
trimethylbenzene				
ethylbenzene				
ethylmethylbenzene				
Halogenated Compounds:				
tetrachloroethylene		large	100,000	EPA
trichloroethylene		small	100,000	EPA, NIOSH
1,1,1 trichloroethane		small	350,000	EPA, NIOSH

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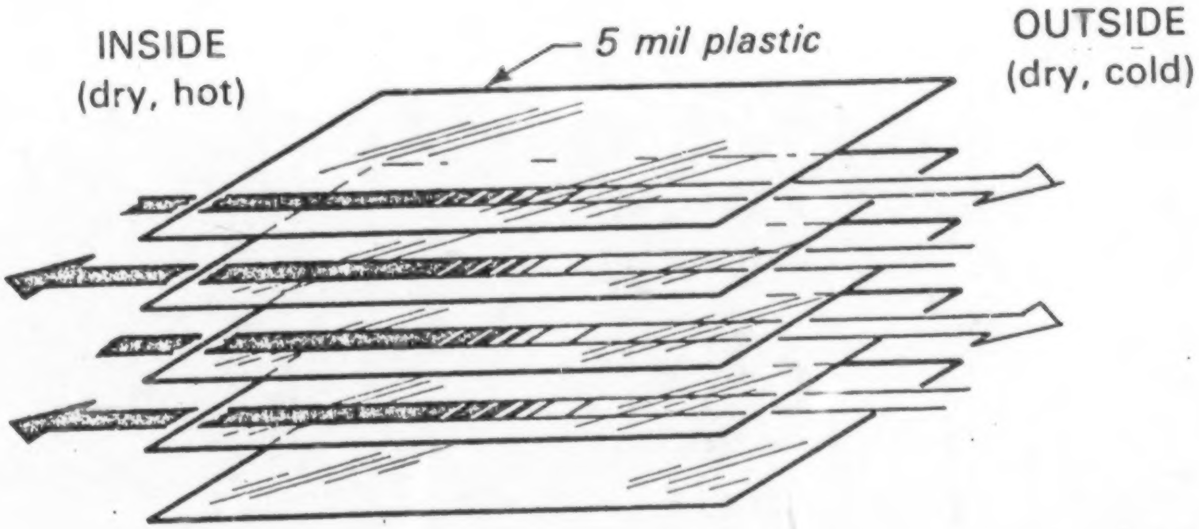
[a] Compounds identified were present in air sampled at an LBL office trailer (90G) and/or a San Francisco office building. Numerical data is for the San Francisco office building only.

[b] Limits for the general public are typically less than or equal to 1/10 or OSHA limits.

HEAT EXCHANGER

WINTER


INSIDE
(dry, hot)
5 mil plastic
OUTSIDE
(dry, cold)

PROF. BESANT'S RESIDENTIAL EXCHANGERS (1 ACH), MODIFIED FROM EXCHANGERS FOR HOG BARNS IN SASKATCHEWAN. COST: $200, PLUS $50 DOLLARS OF FANS AND PARTS TO INSTALL.

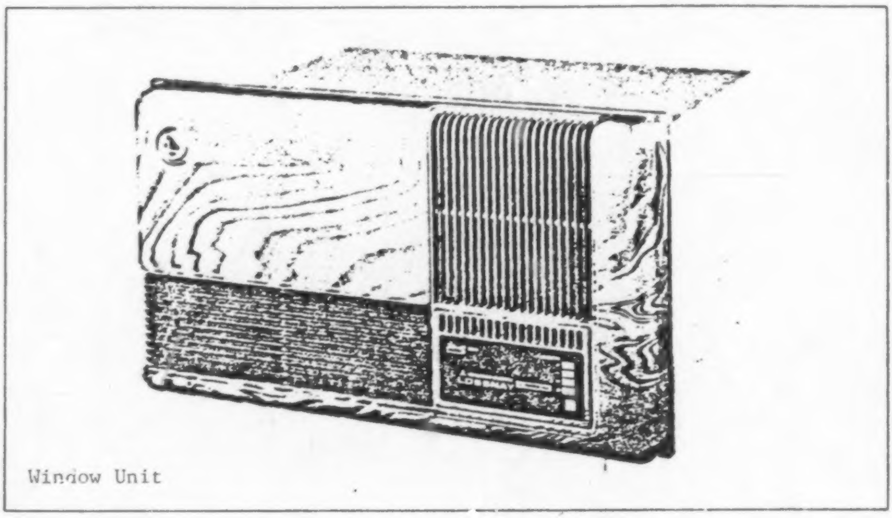
Figure 7. Winter operation of a counter-flow heat exchanger. About 75% of the heat from the warm exhaust air is transferred to the cold supply air.

LOSSNAY FOR RESIDENTIAL USE

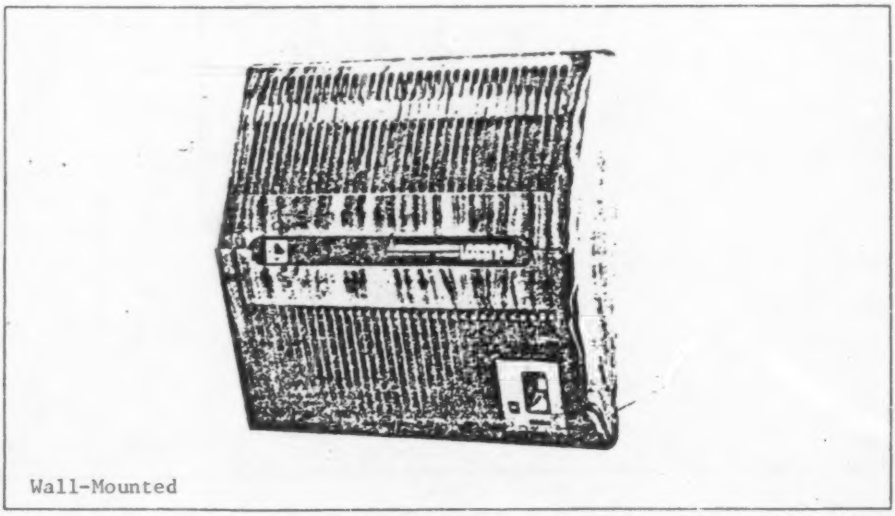
Mitsubishi

$140

VL–1500–M (Wood Panel Type)


Window Unit

VL–1200–M (Wood Panel Type)


Wall-Mounted

NOTE: VL–1500–C and VL–1200–C is White-Panel Type

Figure 8. Residential heat exchangers.

unit. They use only 50 to 150 watts of electric power, and save about 125 therms/year. More precisely, if we take into account savings in both heating (125 therms of gas) plus cooling, the average savings is about 15 MBtu of resource energy, worth about $100/year.

We now consider the potential nationwide savings associated with this savings of 15 MBtu for each new home, and we further consider the year 1990, by which time there should be at least 10 million new dwellings.

The national savings is then 15 MBtu x 10 million homes = 0.15 quad, worth about $1 billion per year, or about $3 million every day. In addition, there are some interesting savings in summer peak power which we mention next.

In summer, a water-permeable heat exchanger can turn around outdoor water vapor as well as outdoor heat, and it is the water vapor that puts 2/3 of the load on an air conditioner in the humid southeast of the United States. A permeable exchanger can save about 1/2 kW of peak power in these warm damp parts of the United States, where perhaps 2.5 million new homes will be built by 1990. That represents an additional savings of 1.3 GW of peak power, which costs our utilities about $1 per installed watt. The capital savings is then another 1.3 billion.

The federal effort so far in heat exchanger testing facilities has cost less than $1 million. For every year that full market acceptance of heat exchangers is accelerated, the nation gains $100 million. This is an excellent rate of return on a modest federal investment. Similarly, the investment in research on specific indoor pollutants, including sources and indoor concentrations, is extremely small compared to the health benefits to be gained by a better understanding of indoor air quality and its maintenance.

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2. Committee on Aldehydes, NAS/NRC, to be published, 1981.
3. Working Group on Health Aspects Related to Indoor Air Quality, WHO, Euro Reports and Studies 21, 1979.
4. A.H. Rosenfeld and M.D. Levine, "Accelerating the Building Sector's Response to Rising Energy Prices," LBL 12 739, Testimony to the House Interior Appropriations Committee, April 8, 1981.
5. D.M. Moschandreas, H.E. Rector, P.O. Tierney, "A Survey Study of Residential Radon Levels," Geomet Technologies Inc. Report ES 877 to LBL Jan. 14, 1981.
6. Because windows in homes are closed only about half of the year, our measurements on radon concentrations and our comparisons with cigarette smoking are worst-case analysis, by a factor of two.

May 26, 1981

Thus is Figure 3 (the Maryland house) we see concentrations climbing to 30 nCi/m^3, and we talk about 300 cigarettes per day. But half of the time, during nice weather, the windows are open and the radon concentration is negligible. Thus the yearly lung cancer risk equivalent to smoking only 15 cigarettes every day of the year.

In Figure 4 (the conventional homes in Mt. Airy) there is yet another factor of two, because the measurements were taken in the summer with the windows closed. But summer infiltration is only about half as great as winter infiltration, because in winter, warm air floats upwards quickly and leaks through holes in the ceiling twice as fast as in the summer.

Mr. SCHEUER. Well, thank you for your remarkably stimulating and thoughtful testimony.

Mrs. Schneider.

Mrs. SCHNEIDER. I would just like to ask, Doctor, What is the National Research Council that you are a member of?

Dr. ROSENFELD. OK, I am sorry. The National Academy of Sciences/NRC is the well-known outfit. For some reason, this particular study uses the words NRC first.

Mrs. SCHNEIDER. I see. The research that you have been developing, some of which you explained to us today, does the National Cancer Institute have the benefit of this research?

Mr. ROSENFELD. Everything that we do is published in the literature. We are not at all that part of DOE which published individual reports—I am sorry, private reports which aren't read. We consider ourselves the core of the research community. We are on a university campus, and reach all the standard journals.

Mrs. SCHNEIDER. I guess the main thing I am asking is it read by the National Cancer Institute? Do you see any evidence of the research that you are generating being picked up and carried beyond the research element into the health field?

Dr. ROSENFELD. Yes; we have no problem with that. The health community, I think, is now well aware of the fact that there is a whole new field. Maybe I should say that there is a whole new field in there, instead of a whole new field out there.

Mrs. SCHNEIDER. Right.

Dr. ROSENFELD. The main problem is the people who don't read it seem to be DOE, who—well, let me be very specific. We started out this year spending like $4 million in indoor air quality. That is not a giant program if it advances the happy day we are saving $4 million a year. You see, it would cost a day's savings to do that. For next year we are told our budget will be $2 million, so we are cut to a half. You put in a little inflation, we are cut to 40 percent. We can see absolutely no reason for that.

Heck, we are not doing commercialization, we are not doing regulation. All we are doing is trying to save people's lungs and we don't understand what problem DOD has.

Mr. SCHEUER. In other words, you are trying to provide the basic knowledge base——

Dr. ROSENFELD. Yes, sir.

Mr. SCHEUER. Upon which cities, counties, States, can act if they wish to act?

Dr. ROSENFELD. That is right.

Mrs. SCHNEIDER. Well, because your testimony was so very thorough, I don't have any other questions. Thank you for answering all of them anyway.

Mr. SCHEUER. Thank you.

Professor, what do you think you would need in terms of research and development funds to arrive at the point where you can say to governments at all levels, "here are the measuring tools, the analytical systems, the data base that you need to address this problem, should we dare to produce it."

Dr. ROSENFELD. OK, first, I want to say that I want to be very careful about excluding that expensive part of essential research, which I don't understand I am not involved in cancer research, and

I make no comments about disease control and so on. But if you ask about such things I understand as making better instruments, reliable survey instruments, a few million dollars a year.

One thing which we are managing to accomplish with the individual States already, but it is very tedious without Federal help, is to try to get the States on the west coast to buy individual vans which cost maybe a $100,000 and we will measure everything about indoor air quality and infiltration and so on from both new buildings and retrofits.

Now, I believe that it would be excellent if amounts like a million dollars a State, every 5 years, could be made available to us to provide these basic tools. The tools are actually cheap compared with operating them. But they are the things the States don't know how to do—that one would all of a sudden see a lot of data flowing in. One would understand where the pockets of radon are; where the factories that are producing the bad formaldehyde are; where the quarries that are producing the radioactive concrete are and so on; and advance our cause a lot.

So in terms of the sorts of things that we have been doing in the national laboratories, we were growing slowly. We were at $3 million, and under Carter we would have gone to $4, and we might have been able to grow a million dollars a year and there are two or three labs in the country doing that sort of thing. But it is a relatively pretty cheap program.

Obviously, I mean this terrible problem of possible synergisms between organics, that is something I don't know. That is a piece of maybe very difficult epidemiology and I wouldn't dare say what it takes to solve the problem.

Mr. **Scheuer**. Well, Dr. Rosenfeld, your testimony has been extaordinarly interesting and provocative and stimulating. I do have some additional questions to ask you, but we have run already a half an hour over our termination, and we still have one more witness. So we thank you very much for your really excellent testimony, and we will be in touch with you.

Thank you very, very much.

Mr. **Scheuer**. We will now hear from the last witness, David Doniger, of the National Resources Defense Council.

Mr. Doniger, we have abused your patience. If you wish to talk informally to us, your testimony will be printed in full in the record.

Then we will have another 15 or 20 minutes to ask you questions.

STATEMENT OF DAVID D. DONIGER, NATURAL RESOURCES DEFENSE COUNCIL

Mr. **Doniger**. I appreciate that.

I will continue your pot pourri of unusual environmental problems related to air that are not getting the attention they deserve.

I am David Doniger, I am here on behalf of the Natural Resources Defense Council which has 45,000 members dedicated to protecting health and the natural environment, and to promoting an energy future for our country that is both environmentally and economically sound.

I would like to talk briefly about some of the health problems of synthetic fuels that are not getting the attention they deserve, and briefly also about parts of the Clean Air Act that are relevent to synfuels.

The conversion of coal and oil shale to liquid and gaseous fuels is, by any technology, an extremely complex chemical process. These things consist of thousands of materials literally taken apart and reassembled, often under very high temperatures and pressures. You get conventional pollutants like sulfur oxides, nitrogen oxides, and particulates, and you get a very, very wide variety of hydrocarbons, trace metals, and organic compounds of which a significant number are well known carcinogens, and many of which are implicated in a large variety of other toxic effects as well.

We have included a table, which is about three pages into the testimony, drawn from work we did critiquing, draft environment impact statements prepared by DOE on several of the projects it has been promoting. The chemicals that are listed here are just representative compounds you would expect to find in synfuels processes, and may be released from them.

The Department of Energy has been providing no information on what chemicals you would expect to find in the processes, in what quantities, where they could get out, what you could do about keeping them tightly controlled—tightly kept inside the process, or what you could do to neutralize them if they have to get out.

Now, what is extremely disturbing is that—at least for the demonstration plants in which the Department of Energy is a partner—major decisions to commit to projects are being made long before they are even designed. You have only vague assurances that the best available technology will be used—assurances offered before any detailed investigation of technological options has even been begun.

DOE and the industrial partners have failed to provide any of the detailed information that would allow one to predict with any confidence the substances that will be flowing through the process and the points at which they might be emitted, and they have given the public no way to know that the truly best technology will actually be used. We see nothing to show that anything is being done to select among the different synfuels processes—something I informally call triage—to select the ones that have the least potential for harm to people and to the environment.

Massive amounts of Federal money are being spent to make the synfuels industry develop far more rapidly than it otherwise would. In order to assure that public health and the natural environment are protected from these air pollutants, as well as from pollutants in other media, it is essential that a substantial portion of the Federal subsidy be targeted for doing the necessary health and environmental effects research and the R. & D. on improved control technology.

This certainly would be a subsidy for private industry, and subsidies are generally to be frowned on. But in this case, there are four compelling reasons why we think it should go forward nonetheless.

First, if the public is going to pay a large part of the cost of developing the synfuels industry, a substantial portion of the public's money should be targeted for health and environmental effects research and control technology development—what the private sector has the least incentive to do well itself.

Second, the biggest problems in these areas are due to the high speed at which Federal involvement is forcing development of the industry. Health effects studies can take several years or longer to complete, even if begun promptly. The synfuels program is making production commitments so rapidly that much research will not have been performed by the time pollution control decisions need to be made. Unless the Federal Government speeds up this research, major health problems may be discovered only after poorly controlled plants are already built and operating.

The third reason is that reliance solely on Federal and State regulatory mechanisms for setting performance standards will result in missing a generation of synfuel plants, because there are no plants in operation yet on which to base pollution control standards. So the agencies like EPA, which feel they have to have a existing example of a technology operating already in order to require its future use, have no such examples on which to base standards.

The fourth reason is that if the private sector does all the health and environmental effects research and control technology development, much of the information may be proprietary. Competitors, and the public, may not learn about the health hazards that one company's research has uncovered. Neither will competitors have ready access to control technology improvements.

Mr. SCHEUER. Let me ask a question here. In the development of a drug, or in the use of a drug, if there is any negative effect, that pharmaceutical house is under a legal obligation to report it immediately to the appropriate Federal agency. I don't think the proprietary nature of their commercial product interferes with their mandate to report any dangerous side effect as their research is developing, or after the product is in use. Why is there a proprietary problem here?

Mr. DONIGER. Well, in fact, Congressman, you are onto something here. There is a provision of the Toxic Substances Control Act which requires anybody who uses chemicals to report to the Environmental Protection Agency whenever it develops or receives information that indicates that there is "substantial risk."

The trouble is that the term "substantial risk" is a soft term, and we don't really have a very good sense of how well that provision is working. There are a fair number of substantial risk notices coming into EPA, but there are also a number of situations in which companies are not reporting hazardous conditions that they are finding because they are afraid of what it might mean for them. It is too easy for companies to decide, well, this risk is not "substantial" and then not report.

It is very much a self-policed thing. It would be very interesting, I think, for the committee to look into how well that reporting mechanism works with the EPA. I don't know what the statistics are for the synfuels industry's reporting anything to EPA on this. If it is not showing up in the DOE environmental impact statements, I doubt it is being reported to EPA.

The other thing is that there is no provision that would require anybody to report an advance in control technology, which they might wish to keep secret. But if the Government is the responsible paying party behind invention of a better valve or better seal or better scrubber or this or that, then that becomes a publicly available innovation, much more quickly and much more cheaply.

Mr. **Scheuer**. Could you give us some recommendations as to legislation, I don't mean legislative language, I mean just substantive language, as to how we should place on to the industry the obligation to report precisely a hazardous condition?

Mr. **Doniger**. Well, in another day, and I hope it will be a future day, what I would suggest is that the Environmental Protection Agency write some definition of what is substantial risk. I don't think Congress really needs to do that, but it may need to instruct EPA to do that. Under such a definition, you would know that if you have a chemical which causes a certain kind of effect in a certain kind of test, it has to be reported.

But the interpretation that EPA has adopted so far—and I would not expect them to change this under their current leadership—is to leave it to industry to decide what substantial risk is and what it isn't.

Mr. **Scheuer**. Might you give us some suggestions as to the kind of programmatic language we might consider that would give EPA a mandate to make some of those value judgments themselves, and place them on the industry?

Mr. **Doniger**. The problem remains, however, that if the private sector does all this research, then some of the technological information may remain proprietary, and perhaps that would be OK if it were all bought and paid for by private sector funds. But the public is subsidizing this work. If shielded by trade secrecy, control technology advances wouldn't be diffused very fast, and might not be diffused at all to competitors. And the public, in the meanwhile, will have to suffer the pollution that could have been controlled.

Now, NRDC believes that the Federal function which we have been discussing of doing research into health effects and environment effects, and also doing work on developing synfuels pollution control technologies would be best performed by EPA because this is the agency that specifically is oriented toward health and environmental protection. At the very least, if it is shared by EPA and DOE, EPA must be in the position in terms of resources and support to be an equal partner.

The Department of Energy has not targeted its support of so-called demonstration plants to protection of health environment. If the demonstration plants don't go forward, DOE will even have less incentive to do this kind of work. We have found that DOE has the same blind spot as industry toward these concerns.

For the long run, NRDC thinks the best way to assure that both the public is protected and that the cost of providing that protection falls where it should, instead of on the public, is to set effective testing requirements and health-related, technology-forcing standards of performance for synfuel emissions. The health and environmental laws already on the books provide most of the authority needed to see that companies test the chemicals they will be using, creating, and emitting, and to see that they develop and install effective controls.

To perform its own R. & D. and to implement these laws effectively, however, the Environmental Protection Agency needs enough highly trained scientists so that the agency can really understand the status of health and environmental effects research and engage in meaningful dialog with their industry peers on the appropriate tests and further research needed on the dangers of these emissions.

Similarly, EPA needs enough highly qualified engineers to understand the state of the art in pollution controls and how they can be improved.

The budget cuts at EPA, however, leave the agency, in our judgment, an unequal match for the task before it. NRDC believes these cuts are unwise. Money spent to beef up EPA's ability to carry out these responsibilities will, in our judgment, have a very high payoff in health and environmental problems avoided.

Mr. **Scheuer**. Let me ask a question here. You know, we are dealing with a condition, not a theory. And the condition is that in this time, in this environment, it is not likely that there is going to be a vast profusion of new professional talent into EPA.

Mr. **Doniger**. It is partly a matter of being able to retain good people they already have.

Mr. **Scheuer**. That is correct. Supposing we were to think of changing the focus, and tell industry that we would like them to conduct this research. Do you think there is some way that, through perhaps a tax credit for part of this research, and perhaps freeing the industry from the restrictions of the antitrust laws, that we could get the entire synfuels industry together to have some kind of a sophisticated, high-powered research and development effort that they would conduct?

Mr. **Doniger**. I think one way to do this, Congressman, is to target some of the synfuels subsidy money. There isn't a need to give them more money in the form of tax breaks, or any other form of subsidy. There is so much subsidy going in already. It is necessary that some of it be targeted specifically, be restricted if you will. It would be used, perhaps jointly through some kind of common research institute, to deal with some of the common health effects problems they have. The targeted money could be used on a project-by-project basis. Some percent of the money should also be set aside for developing better pollution control devices.

The focus of DOE's attention—and we are to some extent fearful the same thing is happening with the Synfuels Corporation—has been simply on how do we turn the coal into a liquid, or the coal into a gas, and not on how do we deal with everything else that is involved in that process, like keeping the "bad actor" chemicals away from people. The focus is on the main event, if you will, and not on any of the side attractions.

Some of that money, and some of that attention, and some of that intelligence needs to be targeted. That kind of targeting I think can be done legislatively. It could be done by the Synfuels Corporation administratively, too. We have been pressing them to do that. We don't have any commitments from them.

Mr. **Scheuer**. You mentioned in your testimony about the heavy subsidies going to the synfuels. It was my understanding that the

Reagan administration has taken the position that the synfuels development should take place as a result of market forces, and that they shouldn't have major Government subsidies.

Mr. DONIGER. To the extent that they have supported some trimming of the subsidies, we have supported that. But there is still $17.5 billion of money available for the Synfuels Corporation to subsidize this industry with. I think what we have done is shave a few percent off the subsidy. That is not cutting into it very deeply.

Mr. SCHEUER. Do you have any suggestion for us as to a specific legislative approach whereby we could place on the Synfuels Corporation the obligation of seeing that the industry did this research, assuming they could work together free from the restraints of the antitrust laws?

Mr. DONIGER. Well, as I said, I don't think the antitrust laws are going to be a serious problem. There already is in the general chemicals industry a Chemical Industry Institute of Toxicology through which they pool resources to do research on some common chemicals they all use, and the synfuels industry could do that too, I think, within the existing antitrust laws. I don't know which committees have jurisdiction to pass laws that affect the Synfuels Corporation.

Mr. SCHEUER. Well, as far as antitrust legislation is concerned, it would be the Judiciary Committee. If we proposed a piece of legislation that would free them up from the constraints of the existing antitrust legislation, assuming that were necessary, then such a piece of legislation would be sequentially referred to the Judiciary Committee.

But I think they would be happy to seriously consider that.

Mr. DONIGER. I think what is needed more than an antitrust change would be a requirement that they target some of the money they let to individual companies, that they require those companies to target a certain percentage toward health and environmental research and a certain percentage toward improvement of technology for controlling air pollutants, and water pollutants, occupational exposure, and hazardous waste control, as well.

Mr. SCHEUER. Now, you are suggesting synfuels ought to place on each company the mandate to do that. I am suggesting collective action by the industry might produce a far more efficient, cost-effective, and intelligent way of conducting that research and development.

Mr. DONIGER. I agree that for problems they have in common, like what is the effect of a chemical that many synfuels processes have to deal with, you are right. Pooled research would be a useful and efficient way to do it. If somebody has got a process for turning coal to synfuels through the Liurgi process versus SRC versus H coal, each of those technologies faces fairly separate control technology problems. There are probably not as many opportunities for pooling technological research there as there are on basic health research.

Mrs. SCHNEIDER. Mr. Chairman, I would like to address a question moving beyond the process into some of the specifics.

Recently there was a study in Scientific American magazine, I believe, that indicated there were mutations of crickets. Are you familiar with this particular study?

Mr. **Doniger**. Science magazine, yes.

Mrs. **Schneider**. These crickets were exposed to coal liquefaction products. I was wondering if you were familiar with any other particular research work that has been done?

Mr. **Doniger**. There is a considerable amount of work that shows that individual chemicals which are known carcinogens from prior work are found in synfuels processes, and are sometimes released from them.

Some of those chemicals are indicated on the chart in my presentation to you. There is also a fair amount of work that shows that individual chemicals and groups of them are mutagenic, in various test systems, most of them involving creatures smaller than crickets.

But you don't really want to test them on creatures bigger than crickets, either. It is not practical and may not be ethical.

Mrs. **Schneider**. Do you know what the followup on this generation of information is?

Mr. **Doniger**. I am concerned generally that the Department of Energy and EPA together don't have a really well-focused, well-structured program for figuring out what is the most efficient research program: What is the set of tests we could perform that would derive the most information for the least money, and let us have, most quickly, some picture of what the spectrum of risks from these chemicals is.

It is fairly haphazard. People are doing tests that happen to be available to be done. People are taking advantage of information that has been developed in other settings.

Mrs. **Schneider**. So you feel that primarily EPA and DOE should be responsible. Are there any other organizations that you feel should be involved or perhaps even should not be involved in this kind of research?

Mr. **Doniger**. Well, I have said a moment ago that I thought that EPA ought to have the responsibility or at least equal share in responsibility. I am concerned that in the Carter administration, while the Department of Energy had a lot of responsibilities for pushing these demonstration projects, responsibilities which the Reagan administration has shown signs of wanting to cut back, DOE was pushing EPA around on questions of what the effects might be and what the control technology that might be appropriate for these plants is.

That is not a healthy situation if you are interested in protecting the environment and can give us help.

Mrs. **Schneider**. Could you also——

Mr. **Scheuer**. Excuse me. On this point, let me mention several Federal agencies just for your comment. The National Academy of Sciences, the National Science Foundation, the National Institutes of Health. Can you see any role for them to play on an advisory basis, perhaps designing the research program?

Mr. **Doniger**. There is a pooled program of all the agencies that have health effects research responsibilities called the national toxicology program.

I think the chairman is the head of NIEHS, of the National Institute for Environmental Health Sciences, Dr. David Rawl. He is in North Carolina.

Mr. **Scheuer.** Is that a Federal agency?

Mr. **Doniger.** It is part of the National Institutes of Health. It is a useful way to coordinate Federal research. I am definitely against recommending that Federal health effects research be taken from EPA and put in the hands of the National Institute for Environmental Health Sciences, for example, which is one proposal that is sometimes made with regard to health effects research for clean air, generally.

The reason is that health effects research has to be related to regulatory needs, and not purely speculative research.

I can give you an example that will focus that point. For investigation certain purely scientific questions of how pollutants cause their ill effects, it makes more sense to study them at high doses rather than at low doses.

But the primary question of interest for a regulatory agency is whether a pollutant causes those same effects at low doses as it does at high one.

A lot of the problems some people have with the general air quality standards, in terms of criticism of the research, are criticisms that go like this: The ozone standard is at 0.12 part per million. We know that ozone causes serious effects in the area of 0.30 to 0.40 part per million, but you don't know much directly about what is happening in the 0.05 to 0.1 to 0.15 range.

If you let just people who are interested in basic scientific questions do the research, they tend to do all the studies at the high levels—0.30 to 0.40 ppm—instead of at the low ones, where answers would be more relevant to public protection and regulation.

Mrs. **Schneider.** I have two questions that I would like to quickly get in, because I just got a note that I have to run out. First of all, are there any coal conversion processes that are better than others?

Mr. **Doniger.** We are doing some work now at NRDC (and obviously, NRDC, whose total budget is only $3.5 million, is not the institution to rely on for this kind of work) to try to provide ourselves some priorities of that kind and some kind of rough indicators.

We think that process of triage needs to be done by our Government, by the Synfuels Corporation, DOE, and EPA. It is not being done.

Mrs. **Schneider.** The other thing I wanted to check out for the record, is in regard to the various studies we have been referring to before, on the cricket eggs and the examples of mutagens as a result of some of the synthetic fuels processes. Do you know whether the SRC-I is an example of a plant that has been producing these types of effects?

Mr. **Doniger.** The cricket problem came from SRC-II, wnich is a sister process to SRC-I. They share a fair number of similarities.

The table that I have in my testimony is relevant to almost every snyfuels process, including SRC I.

The trouble is, nobody has done the work yet to tell us which chemicals come from which processes, and whether you could expect one process to generate a certain chemical that might be troublesome.

There is no information of this kind yet. So no one knows, when they are designing these plants, which chemicals they have to worry about, and how serious it is to worry about those chemicals.

You get, for example, these plants being designed with piping material that is commonly used at oil refineries. Well, that is not good enough for snyfuels plants because the stuff that rolls through those pipes is more abrasive and corrosive than conventional oil that is being refined.

As a result it leads to more wear on the inside of those pipes and more leakage from valves and pumps and seals.

You need to use better quality and, unfortunately, more expensive piping, valves, seals, and materials. We don't see anybody interested in asking that question within DOE or the industry at this point.

Mrs. **Schneider**. Thank you very much for bringing that to our attention. You can be sure at least some of the members of this committee will ask that question in the coming weeks. I thank you for your testimony. I am afraid I have to run. Thank you.

Mr. **Doniger**. Thank you for staying this late. I just want to point out that the latter part of my testimony is an attempt to rebut claims that you will be hearing that the prevention of significant deterioriation limits imposed by the Clean Air Act are a barrier to oil shale production. They are not.

And to the extent you hear that claim made as a reason for scrapping the PSD system, I hope that you will look at that claim closely. I have got some information presented to you on that point.

And I think it shows there is plenty of room for oil shale within the budgets for new pollution that the Clean Air Act already allows.

Mr. **Scheuer**. Well, you have been extremely patient in working this late.

Mr. **Doniger**. May I make one other Clean Air Act point. Besides not having to bust the PSD program in order to make room for synfuels, there is a need to make one fairly major change in the Clean Air Act in order to protect people from synfuels air pollution. That is the toxic pollutants part of the Clean Air Act, so-called hazardous air pollutants in the parlance of that act.

There is a provision that calls for EPA to control pollutants that can cause cancer or other very serious diseases, particularly at low doses. Section 112 of the Clean Air Act.

It is almost entirely discretionary for EPA, though, to use this section. And in 11 years, EPA has controlled four pollutants under this section.

Mr. **Scheuer**. How many potential pollutants are there?

Mr. **Doniger**. Well, they have seven that they have recognized, only four of which they have controlled. And over 40 which they have been examining over and over again, and refusing to come to a decision on.

We have, through a very rough cut through the literature, identified a number, I would say at least several dozen beyond those 40 which are both reported in the literature to cause cancer and reported in the literature to be in the air from one source or another.

Not all of those are synfuels problems. They come from many different kinds of sources, chemical plants, oil refineries, coke ovens, smelters, and synfuels plants (as many of the latter that are built).

I anticipate those to be the five major categories of those kind of pollutants. What is needed is an amendment to the Clean Air Act that forces the front end of that process and makes EPA give some serious attention and resources to the problem of hazardous air pollutants. EPA must be made to make some up or down decisions about whether those 40 pollutants that they have been kicking around for a long time are, in fact, hazardous or not, and whether they should be controlled.

Also, they should be instructed to make much more vigorous efforts to identify additional pollutants that may know cause cancer or other serious diseases and may be in the air, and then to evaluate them and make decisions about whether they need to be controlled.

Four pollutants ever 11 years is not going to put a dent into the toxic pollutant problem, it is not going to handle the problem of toxic pollutants from synfuels.

Mr. SCHEUER. Well, if we raise this question with EPA, would they come back and tell us that these four chemicals amount to 97 percent of the pollutants?

Mr. DONIGER. No, the four chemicals we are talking about are important. They are: asbestos, beryllium, mercury, and vinyl chloride.

The three other pollutants that are recognized but not controlled yet are benzene, arsenic, and a group of pollutants called radionuclides (the outdoor version of the radon problem that your prior witness was talking about).

There are other chemicals on that list of 40 which are emitted in higher volume than some of the ones they have already recognized.

Mr. SCHEUER. Are these just as toxic potentially?

Mr. DONIGER. Yes. although among chemicals that you know cause cancer, it is difficult to say reliably which one is more potent than another and by how much.

Mr. SCHEUER. Which of those chemicals that they haven't issued standards for do you think are important health risks?

Mr. DONIGER. One of them is formaldehyde, which is not only an indoor problem, but an outdoor problem. I have not got the list memorized, and I cannot call the other 39 to mind right now.

Mr. SCHEUER. Well, we would be happy——

Mr. DONIGER. Acrylonitrile is another chemical, like vinyl chloride, used to make plastic and it is a problem which EPA was very close last fall to regulating.

There are a number of chlorinated solvents, trychloroethylene, perchloroethylene, methyl chloride and so on that EPA was once close to regulating and has backed off on.

These are pollutants which are responsible, we think, for a fair number of cancer deaths every year. As a whole, the toxic pollutants problem is one of the major undealt-with problems of clean air.

It is, in the National Clean Air Coalition's opinion, it has the same rank of importance as dealing with acid rain.

Mr. **Scheuer**. Would you submit to the committee for the printed record a list of those 40 chemicals, describing the ones that you think are, in addition to the 4 that EPA has looked at, that merit serious analysis and evaluation for their potential toxicity?

Mr. **Doniger**. Yes, I will. All of them do. If EPA came out with a decision and said, "Of these 40, we are going to regulate 30 of them, and 10 of them either because they are low volume or because the health effects information is not adequate on them, we don't have quite what we need on them, we are going to defer regulation on," and provided these conclusions were supported, we could accept a decision like that.

It would have to be a a well-supported, well-articulated priority setting judgment. We have been unable to get EPA to fish or cut bait on these chemicals.

They have spent 4 years dawdling over a general policy about how to approach these chemicals, instead of acting on them.

For a while, we thought pursuit of the general policy was a good idea, because we thought it would resolve some general recurring issues once and for all, and then they would no longer hold up a particular chemical's regulation.

But instead, what has happened is that EPA still hasn't resolved those general questions, and this new EPA leadership is not likely to do that unless Congress passes an amendment to the Clean Air Act which says, "Speed up the toxic pollutant identification, analysis, and regulation."

And we in the National Clean Air Coalition have proposed such amendments—not in language yet, but in concept.

Mr. **Scheuer**. We can provide the language if you would provide the concept. I should state for the record, and I think there is a real concensus on this, that we are not trying to create a risk-free society.

What we are looking for, I think our goal should be is to put more pressure on EPA, in fact, mandate that EPA look at the significant threats to the national health that come from synfuels, and direct them to analyze and evaluate the chemicals that potentially would produce a significant high order of magnitude threat to the national health.

We can't ask them to do everything. So I would like you to help us sort of fine-tune our aim, and get to the major target of opportunity.

Mr. **Doniger**. One of the problems in the synfuels area as I was trying to say from the outset, is that we don't know very much about the risks from synfuels, because no one who has been spending the money has been very interested in asking those kinds of questions.

Obviously, NRDC and all the environmental organizations realize that, as a practical matter, we are not going to see total elimination of risks. Zero risk was never a goal of these laws, even 10 years ago, and it seems to me that the claim, as the Congressman is well aware, that any measure that is being proposed is a zero-risk measure is not a very useful claim for industries to be making at this time. But it is a canard in many instances. These are not zero-risk measures. There are measures to reduce risks to levels which may reduce the total effect on human life and health.

Mr. SCHEUER. Mr. Doniger, you have given us extremely helpful testimony. We may be asking for some further information in the future.

We have gone well over an hour overtime. We thank you for your indulgence and patience and your very excellent testimony.

Dr. DONIGER. Thank you very much.

[The prepared statement of Mr. Doniger follows:]

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Testimony of

David D. Doniger

on

"Air Pollution, Synthetic Fuels, and Research and Development"

Before the

Subcommittee on Energy Development and Applications

and the

Subcommittee on Natural Resources, Agriculture Research, and Environment

of the

House Committee on Science and Technology

May 28, 1981

My name is David Doniger. I am speaking today on behalf of the Natural Resources Defense Council, a national citizen organization of more than 45,000 members dedicated to protecting public health and the natural environment, and to promoting an energy future for our country that is both environmentally and economically sound. Thank you for the opportunity to testify today on the problem of air pollution from synthetic fuels development and the proper role for government research and development, subsidies, and regulation.

1. Health Effects Research, Technology Development and Synfuels

The conversion of coal and oil shale to liquid and gaseous fuels is, by any technology, an extremely complex chemical process. Coal and oil shale consist of thousands of chemical compounds. In synfuels processes they are literally taken apart and reassembled, often under very high temperatures and pressures. Several of these compounds -- notably sulfur oxides, particulates, and nitrogen oxides -- are well recognized pollutants. Many other compounds are known or suspected to present serious risks to human health, including cancer and other chronic illnesses. Prominent offenders are polycyclic aromatic hydrocarbons (a large class of well known carcinogens, such as benzo(a)pyrene) and toxic metals and other elements (such as arsenic and mercury). A table of representative compounds and effects, drawn from the comments of NRDC and the National Wildlife Federation on the Draft Environmental Impact Statements for demonstration projects supported by the Department of Energy is attached. It is reasonable to anticipate the presence or formation of these and many more dangerous compounds in any of the synfuels processes.

The risks will be felt by people who work at the plants and by those who life around them. In addition, the risks will fall on users of synfuels too, because even the products can be more dangerous than those they replace.

Some health effects research is being conducted by the Department of Energy and the Environmental Protection Agency. But so far as we can determine, the work is incomplete and somewhat haphazard. There is no coordinated plan for the federal government to assess systematically the extent of the health hazard these chemicals may pose through air pollution, as well as through contamination of workplaces, water, wastes, etc.

There is reason to believe that synfuels plants, if not well planned and well controlled, will release these toxic compounds to the air in substantial amounts. People living and working in the vicinity will be at risk. Volative organic compounds and trace metals may be allowed to leak routinely from valves, pumps, flanges, and seals. Similar regular emissions may come from plant flares or other devices (such as cooling towers or "controlled combustors"). Major pollutant releases

Table II-1: Summary of Toxic Chemicals and Effects

Chemical	Carcinogenic	Causes Chromosome Damage	Teratogenic	Other Reproductive and Developmental Toxicity	Neurotoxic	Toxic to Other Organ Systems
Polycyclic aromatic hydrocarbons	+	+				
Benzene	+					
Aniline	+					+(interferes with blood's ability to carry oxygen)
Indole	+					
Quinoline	+					+(skin, eye)
Phenols	(promoters)	+				
Cresols		+				
Thiophene					+	+(liver, kidneys, heart, blood)
Hydrogen sulfide			+		+	
Carbon disulfide			+	+	+	
Arsenic	+					
Mercury			+		+	+(kidneys)
Nickel	+					+(skin)
Chromium	+					+(skin)
Lead	+			+	+	+(kidneys, blood-forming system)
Cadmium	+	+	+	+		

Source: Comments on The Draft Environmental Impact Statement For The Proposed SRC-II Demonstration Plant

National Wildlife Federation, Natural Resources Defense Council, Inc.

may be expected as a result of frequent plant "upsets" caused by equipment failures or conditions of runaway temperature or pressure requiring rapid purging of reaction vessels.

What is extremely disturbing is that -- at least for the "demonstration" plants in which the Department of Energy is a partner -- major decisions to commit to projects are being made long before they are even designed. Vague assurances that the "best available control technology" will be used are being offered before any detailed investigation of technological options has even begun. DOE and the industrial partners have failed to provide any of the detailed information that would allow one to predict with any confidence the substances that will be flowing through the process and the points at which they might be emitted, or to be assured that the truly best technology to control such emissions will be used. In addition, we see nothing to show that thought is being given to preferring the "cleanest" synfuels technologies, the ones that least threaten health and the environment.

Massive amounts of federal money are being spent to make the synfuels industry develop far more rapidly than it otherwise would. In order to assure that public health and the natural environment are protected from these air pollutants, as well as from pollutants in other media, it is essential that a substantial portion of the federal subsidy be targetted for doing the necessary health and environmental effects research and the R&D on improved control technology.

This support for scientific research and control technology development certainly would be a subsidy for private industry, and subsidies are generally to be frowned upon. But in this case there are compelling reasons why it should go forward nonetheless.

First, NRDC believes that if the public is going to pay a large part of the cost of developing the synfuels industry, a substantial portion of the public's money should be targetted for health and environmental effects research and control technology development -- what the private sector has the least incentive to do well itself.

Second, the biggest problems in these areas are due to the high speed at which federal involvement is forcing development of the industry. Health effects studies can take several years or longer to complete, even if begun promptly. The synfuels program is making production commitments so rapidly that much research will not have been performed by the time pollution control decisions need to be made. Unless the federal government speeds up this research, major health problems may be discovered only after poorly-controlled plants are already built and operating.

Third, relying solely on federal and state regulatory mechanisms for setting performance standards will result in missing a generation of synfuel plants, for there are no plants yet on which to base pollution control standards.

Fourth, if the private sector does all the health and environmental effects research and control technology development, much of the information may be proprietary. Competitors, and the public, may not learn about health hazards that one company's research has uncovered. Neither will competitors have ready access to control technology improvements.

NRDC believes these functions would be best performed by EPA -- the agency specifically oriented towards health and environmental protection. At the very least, if the role is shared by EPA and DOE, EPA must have the resources and support to be an equal partner in this relationship. NRDC believes the Department of Energy has not targetted its support of the so-called "demonstration" plants toward protection of health and the environment. Rather, DOE has largely shared the same blind spot toward these concerns -- which should be integral to design of these plants -- as its private co-sponsors.

For the long run, NRDC believes the best way to assure both that the public is protected and that the cost of providing such protection falls where it should is to set effective testing requirements and health-related, technology-forcing standards of performance for synfuel emissions. The health and environment laws already on the books provide most of the authority needed to see that companies test the chemicals they will be using, creating, and emitting, and to see that they develop and install effective controls.

To perform its own R&D and to implement these laws effectively, however, the Environmental Protection Agency needs enough highly-trained scientists so that the Agency can really understand the status of health and environmental effects research and engage in meaningful dialogue with their industry peers on the appropriate tests and further research needed on known and potential emissions. Similarly, EPA needs enough highly-qualified engineers to understand the state-of-the-art in pollution controls and how they can be improved.

With sufficient resources, EPA will be able to set standards based on reasonable assessments of danger, the current state of control technology, and how it can be reasonably expected to improve with an appropriate R&D investment by the private sector.

The budget cuts at EPA, however, leave the Agency, in our judgment, an unequal match for the task before it. NRDC believes these cuts are unwise. Money spent to beef up EPA's ability to carry out these responsibilities will, in our judgment, have a very high pay-off in health and environmental problems avoided. Especially if the federal government is subsidizing synfuels development generally, this minimal expenditure for EPA's research and regulatory functions seems simply essential.

Let me turn for a few moments to the subject of these health and environmental laws themselves -- in particular the Clean Air Act, which is up for amendment this year.

2. Synfuels and the Clean Air Act

As the debate over the Clean Air Act begins, some voices in the synthetic fuels industry are saying the law needs to be changed. It may surprise some of you (at first) to hear that I agree. The Clean Air Act does need to be changed on account of synfuels development -- but not exactly as these voices have suggested.

Where the Clean Air Act needs to be changed on account of synfuels is in the area of toxic air pollutant control. Synthetic fuel plants pose potentially serious risks to public health due to the emission of an extremely large number of known and suspected toxic pollutants. While the Clean Air Act now contains some provisions for regulating these pollutants ("hazardous air pollutants" in the parlance of the Act), the substances of concern in synfuels projects are today completely unregulated. Major Congressional action is needed to speed up the control of toxic air pollutants from many categories of industrial sources, including synfuels plants.

Where the Clean Air Act does not need to be changed is in the area of "Prevention of Significant Deterioration" (PSD) -- the program of pollution "budgets" for protecting our still clean air resources. The evidence shows that the PSD requirements do not bar, or even substantially hamper, the development of a synthetic fuels industry of any realistic size, provided technologies are wisely chosen and individual plants are well planned, well sited, and well controlled. Without the PSD pollution budgets, however, synfuels plants are likely to cause major degradation of our air resources, destroying areas of great beauty, endangering health, and eventually precluding balanced growth in many areas.

The PSD provisions we have and the toxic pollutant provisions we need both can contribute to the development of an industry that is as benign to health and the environment as possible. This is, or should be, everyone's goal.

Let me discuss these two areas for a few moments.

Toxic Pollutant Control

I have already summarized some of the toxic air pollutant hazards sunfuels technologies are likely to pose. The hazardous pollutant provisions of the Clean Air Act need to be improved to assure that EPA will take the steps needed to control these pollutants.

While EPA has some authority to control these pollutants, that authority is largely discretionary, and EPA has done very little about toxic pollutants from any type of industry. In 10 years the Agency has set standards for only four hazardous air pollutants. None of these standards cover synfuels processes, and at least for a few years, there isn't, to be realistic, much prospect that EPA, without a Congressional mandate, will take the aggressive action needed to deal with the synfuels problem.

The National Clean Air Coalition, of which NRDC is a part, has proposed the needed improvements to speed up toxic pollutant control, which Congress will be considering this year. If these improvements are not made, synfuels plants may seriously endanger public health.

Prevention of Significant Deterioration

In this town, things tend to be accepted as "fact" if only they are repeated enough. A concerted effort is being made, through constant repetition, to make it the conventional wisdom that the Clean Air Act's PSD provisions substantially interfere with synfuels development. This claim has become an important predicate for proposals to scrap the pollutant budget system -- the "increments" which limit the amount of new sulfur oxide and particulate pollution that may be added in areas currently with clean air.

The claim is usually put in the context of the oil shale industry. Such companies, such as Exxon, venture wildly unrealistic estimates of potential oil shale production -- disregarding water problems, social and economic issues, and other environmental questions in addition to air pollution, as well as the concerns of the State of Colorado, where most of this development would take place. Not surprisingly, under these assumptions a case can be constructed that the PSD budgets pose some problems. Other critics, engaging in "worst-case" analysis extreme enough to make environmentalists blush, have sought to exaggerate problems the industry may encounter living within the established budgets, in order to maximize the chances of making them appear unreasonable.

Well, let is interrupt with some evidence that the oil shale industry can be built and operated within the pollution budgets of the PSD system.

- EPA estimates that 400,000 bpd of facilities polluting no more than the Colony facility (thought to be the current best performer) could be built without violating any short- or long-term PSD pollution budgets.
    - There is still substantial conservatism built into this model, such as the assumption that the "worst-case" stagnant weather will persist a full 24 hours. If the worst-case weather were assumed to last only 12 hours at a time, 800,000 barrels would fit.
    - The modelling assumed all facilities would be no dirtier than Colony -- perhaps this should be a requirement rather than an assumption.
    - The modelling also assumed uniform mixing of the pollution in the box. If the various assumptions are all considered, 400,000 bpd appears a safe figure, probably an underestimate.

- The National Commission on Air Quality (NCAQ) concluded 940,000 bpd oil shale could be produced in Colorado and Utah, including 670,000 bpd in the Piceance Basin, within the PSD budgets.
- A study for EPA by Systems Application, Inc. estimated 800,000 bpd could fit.
- Just a few weeks ago, Occidental filed an application for a 125,000 bpd operation that would consume only 10 percent of the PSD Class I budget at nearby Class I areas. This suggests an industry of 1,250,000 bpd could be build in the Piceance Basin alone.

How do these projections compare with the anticipated size of the industry: Some 62,000 bpd of production have already received permits. The State of Colorado projects an industry with a maximum size -- for many economic, social and environmental reasons beyond air pollution concerns -- in the range of 250,000 through 400,000 bpd, with the reality more likely nearer the low end of the range than the high. Colorado believes that water availability could prove a limit in the 450,000 to 700,000 bpd range. As the NCAQ concluded:

> Even if oil shale production of 940,000 barrels per day could be accommodated in Colorado and Utah [within the PSD limits], it is unclear what level of oil shale development will actually occur. The level will depend on a wide variety of resource, economic, political, sociological, and technological factors.

Those who propose to eliminate the PSD budgets claim that another element of the program -- the review for "best available control technology (BACT) -- can protect air quality. This claim is wrong -- BACT alone cannot protect clean air.

- Under the Clean Air Act, BACT, despite its name, is not "best" control technology. Rather, BACT for each plant represents a balancing of air quality concerns and economic considerations. Without a pollution budget, individual BACT determinations will be lenient, due to the perception that there is no cost to using up the clean air resources. The pollution budget provides a powerful incentive to make better BACT decisions.
- Without a pollution budget there will be no market pressure to spur the investment in research and development that is needed to improve control technology over the long term. The pollution budget creates pressure for innovation that is essential to having economic growth without environmental degradation.
- BACT alone will not require clusters of sources to have controls sufficient to prevent significant pollution increase in an area.

With synfuels, we can expect BACT review alone, detached from any air quality budget concerns, to be very lenient, for there are not yet even new source performance standards (NSPS's) providing a floor for the BACT determinations. Indeed, the developers of some plants are seeking PSD permits before doing the design work needed to support emissions estimates. In place of the supporting data they offer EPA only vague assurances that "BACT will be used." They provide no basis for deciding whether the plant will perform as promised, or whether it could be designed and built to do better. These applications are not a valid basis for granting PSD permits.

BACT is not a substitute for the PSD budget program; it is merely a tool which can be used to support the objective of staying within the budget. If the budget objective is eliminated, however, today's BACT decisions will become lax and future technology will not improve. As a result, areas that now have clean air will become steadily dirtier.

The National Academy of Sciences, in its recent comprehensive review of the PSD program, emphasized the need for both a technology requirement and a budget limiting future emissions growth. The current PSD program, the NAS concluded, is "basically sound" and can be improved administratively within the framework of the current law.

The National Clean Air Coalition therefore opposes proposals to eliminate the PSD budgets. Some have complained about the complexity of the permit process. The National Clean Air Coalition recognizes that some things can be done to simplify permitting. We have proposed measures to simplify the PSD permitting process without gutting the protection it is supposed to provide. We are open to considering other simplifying proposals that do not destroy the objective of protecting our clean air resources.

The track record of the present program, even before simplification, demonstrates that we can protect our air quality resources without disrupting economic growth or energy supplies. Several hundred PSD permits have been issued so far, and only two were turned down even initially. Those two were approved when better controls were applied. The program has not caused significant delay in construction. According to the National Commission on Air Quality, 75 percent of all PSD permits were issued in 10 months or less. When significant simplifying changes are implemented, the National Clean Air Coalition believes the program can produce the same benefits with even less cost and time consumed.

* * * * * * * * * * * * * * * * *

I would be happy to answer any questions you may have.

Mr. SCHEUER. Before we wind up this hearing, I want to express my thanks to the staff of the Subcommittee on Energy Development and Applications, especially Rich Robinson, for the excellent job that they have all done in assisting in the preparation of these hearings.

Thank you very much. The hearing is adjourned.

[Whereupon, at 5:08 p.m., the hearing was adjourned.]

APPENDIX

ADDITIONAL QUESTIONS AND ANSWERS FOR THE RECORD

DON FUQUA, FLA., CHAIRMAN

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MINORITY STAFF DIRECTOR

June 11, 1981

Mr. Richard Penna
925 Highland Drive
Silver Spring, Maryland 20910

Dear Mr. Penna:

The Subcommittee on Energy Development and Applications and the Subcommittee on Natural Resources, Agriculture Research and Environment were pleased to receive your testimony on the status and direction of research and development under the Clean Air Act on May 19, 1981. As you may recall, you agreed to answer any further questions the Subcommittees might submit in writing. We would appreciate your answering the questions indicated below, and making any corrections you wish to your comments in the enclosed transcript of the proceedings as soon as possible. We are attempting to complete our report on the Clean Air Act by the end of June, and we need this information to be able to do so. Thank you for your kind attention to this matter.

Questions

1. Comprehensive amendments were proposed recently by Congressman Broyhill to broaden the data support for issuance of air quality criteria to specific identification of the scientific basis for specific pollutant listing, which would:

a. Include a description of the natural or background level of the pollutant;

b. Determine the validity of scientific acceptability of the design, methodology, analytical techniques, results, and reported conclusions for essential studies;

c. Repeat critical clinical or toxicological studies prior to promulgation of standards if the Administrator or the Clean Air Science Advisory Committee determines that the studies are of questionable valadity;

d. Examine the nature, frequency, duration, reversibility, and severity of all demonstrated and confirmed effects on public health and welfare;

e. Analyze the exposure of susceptible individuals to concentrations sufficient to cause adverse effects; and

f. Require approval of the final criteria documents by the Clean Air Scientific Advisory Committee.

How would passage of these amendments change the R&D program at EPA? Industry-wide?

2. Another amendment by Mr. Broyhill would change the guiding language for primary clean air standards in Section 109(b)(1) of the Act from "allowing an adequate margin of safety, are requisite to protect the public health," to "are requisite to protect the public health from significant risk of adverse health effects."

What would be the effect of this amendment on the R&D program at EPA? Industry-wide?

3. Another amendment by Mr. Broyhill to Section 112 of the Act regarding national emission standards for hazardous air pollutants (NESHAPS) would provide that no new pollutant may be listed prior to independent review by the Clean Air Science Advisory Committee on the pertinent scientific evidence.

What is your opinion of this amendment?

4. What should be the overall roles of the industry and the Federal Government in air pollution R&D in the short-term? In the long-term?

5. Where should industry place its R&D emphasis in air pollution in the short-term? In the long-term?

6. Where should the Federal Government place its R&D emphasis in air pollution in the short-term? In the long-term?

You may send all material to: Richard Robinson, Room B-374 of the Rayburn House Office Building, Washington, D.C. 20515. If you have any questions, contact Mr. Robinson at 225-4494.

Sincerely,

JAMES H. SCHEUER
Member of Congress

JHS:Rww

Texasgulf Inc.
High Ridge Park Stamford, Connecticut 06904 (203) 358-5000

June 26, 1981

Honorable James H. Scheuer
Committee on Science and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D. C. 20515

Dear Congressman Scheuer:

This is in response to your letter of June 11, 1981 in which you listed several additional questions raised by the Subcommittees after the May 19, 1981 hearings on the status of research and development under the Clean Air Act. Since the time of those hearings I have accepted employment with Texasgulf Inc. The responses I am providing, however, do not represent the views of Texasgulf Inc., but rather represent my personal views or the recommendations of the National Commission on Air Quality.

Responses:

Question 1: The enactment of the amendment proposed by Congressman Broyhill regarding data support for the issuance of air quality criteria would not significantly alter either EPA's or industry's research and development activities. However, some minor alterations particularly in EPA's activities may be necessary. The most significant changes to EPA's program may be: the unanticipated expenditure of funds to repeat critical clinical or toxicological studies; and the necessity to perform studies analyzing the exposure of susceptible individuals to various concentrations.

If this amendment is enacted a special appropriation for purposes of carrying out the requirement to repeat critical studies should be considered by Congress. The purpose of this appropriation would be to assure that funds are not diverted from ongoing research and development activities in order to carry out these studies. In addition, the requirement to perform studies to determine effects on susceptible individuals may require new legal and medical review prior to carrying out such studies since the human subjects have some form of sensitivity to one or more pollutants (e.g. the subjects may be asmatics or persons with other medical problems).

I believe the proposed amendment would not alter substantially industry-wide research and development activities. The most significant change may be a greater emphasis by industry in support of studies on susceptible individuals.

Question 2: Congressman Broyhill's amendment to modify the language in Section 109(b)(1) of the Act regarding primary national ambient air quality standards would have little impact on research and development activities at EPA and in private industry. This is because any form of risk assessment involves an analysis of existing studies regarding the effects of pollution on human health. Both EPA and industry would continue to perform or support the performance of studies regarding the health effects of the various air pollutants. These studies would then be analyzed by EPA under whatever risk assessment procedure is selected for use by the Agency.

Question 3: The proposed amendment to Section 112 which would require review by the Clean Air Science Advisory Committee (CASAC) prior to listing of any new pollutant appears to be an attempt to require by statute a process which is currently undertaken pursuant to EPA policy. Under EPA's proposed Airborne Carcinogen Policy, prior to listing a substance under Section 112 evidence of the risks associated with the substance are presented to a sub-group of the Science Advisory Board called the Subcommittee on Airborne Carcinogens (SAC).

While Mr. Broyhill's proposed amendment would require this review by a different group of experts, I believe the practical effect of this distinction is small, since both CASAC and SAC consist of highly qualified experts in air pollution health effects. In order to assure that the review does not unduly delay the listing of substances under Section 112, it may be appropriate to provide that the required review be completed within a reasonable time from the date EPA submits the documents to CASAC for review.

Question 4: Generally, I believe that EPA should perform research directed to the health and ecological effects of pollutants, while industry should conduct research into improving control technology, the development of inherently low emission processes, and the health and ecological effects of various substances.

As I indicated in the full text of the testimony given May 19, 1981, I believe that EPA should not conduct research and development activities for pollution control equipment or inherently low polluting industrial processes except in quite limited circumstances. These could include, for example, the synthetic fuels industry due to the possibility of substantial governmental support, or where there is a particularly difficult problem which cuts across numerous industries -- such as control of oxide of nitrogen emissions from boilers.

Question 5: Consistant with the answer to Question 4, I believe that industry's short term research and development emphasis should be on control technology for fine particulate emissions, control technology for oxides of nitrogen emissions, and control technology for hazardous air pollutants. In the area of health effects research, short-term emphasis should be placed on research into the effects of various potentially hazardous substances.

Long term emphasis should be placed on the development of industrial processes which are economically efficient and which have inherently low levels of emissions. In the health and ecological effects area, emphasis should be placed on the long term effects of combinations of substances in the environment.

Question 6: The federal government should place emphasis in the short-term on research in the following areas: transformation of sulfur dioxide and oxides of nitrogen into acid precipitation; health effects of substances which may be candidates for possible regulation as hazardous pollutants; health effects of fine particulate matter; visibility impacts associated with fine particulate matter; and control technology for oxide of nitrogen emissions from stationary sources.

As I indicated in my testimony, EPA should place greater emphasis on basic, long term research into health and ecological effects of pollutants. In particular, emphasis should be given to the long term effects, if any, of chronic low level exposure to single pollutants, as well as the effects of these pollutants in combination with other pollutants. In addition, EPA should place priority on determining the long-term impact on the global climate of the build up of carbon dioxide in the atmosphere.

I hope that these answers are useful to the Subcommittees' work. I will be happy to provide whatever assistance I can to the Subcommittees in the future.

Sincerely,

Richard A. Penna

Richard A. Penna

RAP:js

ANSWERS TO QUESTIONS 1 - 8
BY DAVID SWAN RE TESTIMONY OF May 19, 1981
BEFORE THE SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS AND THE SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

Q. 1 Comprehensive amendments were proposed recently by Congressman Broyhill to broaden the data support for issuance of air quality criteria to specific identification of the scientific basis for specific pollutant listing, which would:

1. Include a description of the natural or background level of the pollutant;

2. Determine the validity of scientific acceptability of the design, methodology, analytical techniques, results, and reported conclusions for essential studies;

3. Repeat critical clinical or toxicological studies prior to promulgation of standards if the Administrator or the Clean Air Science Advisory Committee determines that the studies are of questionable validity;

4. Examine the nature, frequency, duration, reversibility, and severity of all demonstrated and confirmed effects on public health and welfare;

5. Analyze the exposure of susceptible individuals to concentrations sufficient to cause adverse effects; and

6. Require approval of the final criteria documents by the Clean Air Scientific Advisory Committee.

How would passage of these amendments change the R&D program at EPA? Industry-wide?

A. 1. One persistent criticism leveled at EPA has been directed at the quality of decionmaking in the scientific and technical areas. See, e.g., National Academy of Science (National Research Council), Decision

Making In The Environmental Protection Agency, pages 45-51 (1977). A solid underpinning of accurate scientific data and objective review of these data is essential in standard setting and regulation under the Clean Air Act. Moreover, it has become increasingly clear that there exists substantive scientific uncertainties in our current knowledge in areas central to standard setting and development. Thus, for example, there are major gaps in our understanding of the nature of a "health effect," in defining it in medically or physiologically significant ways. Further, in the case of most regulated pollutants, the scientific community has yet to develop validated dose-response models.

Both amendments proposed by Congressman Broyhill should serve to better define the EPA standard setting process, and assure that future standards are founded on more solid technical and scientific footing. In the process, these amendments also should serve to accelerate the forces already at work at EPA to redirect R&D efforts toward an effective air quality standards development research program. To the extent that clean air standards and regulations must reflect a more rigorous scientific basis, then R&D efforts at EPA should be more closely tied to the questions surrounding the adequacy of the current standards and development of additional standards.

Recently, EPA's Clean Air Science Advisory Committee (CASAC) of the Science Advisory Board has devoted a substantial effort to reviewing the standards research program at EPA. CASAC seems prepared to recommend additional research efforts in support of standard setting at EPA.

Adoption of the Broyhill amendments should have at least one immediate salutory effect on industry R&D efforts. If, as expected, these changes to the Clean Air Act result in a sounder scientific basis for EPA decision-making, and therefore more widely-accepted standards. One clear benefit will be that fewer scarce scientific resources will need to be devoted to replicating and refuting questionable research results, and will be available for conducting more pioneering research programs.

Q. 2 Another amendment by Mr. Broyhill would change the guiding language for primary clean air standards in Section 109(b)(1) of the Act from "allowing an adequate margin of safety, are requisite to protect the public health," to "are requisite to protect the public health from significant risk of adverse health effects."

What would be the effect of this amendment on the R&D program at EPA? Industry-wide?

A. 2. Introducing the concept of risk assessment into the standard setting process would require EPA to develop appropriate risk assessment techniques and to identify a number of parameters comprising "public health" which are not necessarily now considered in the process. These would include identifying that particular population at risk, measuring that population's exposure to pollutants at levels which might cause incapacitating effects, verifying medical and physiological impacts on the particular population concerned.

If adopted, the amendment would require substantial commitment of both EPA and industry R&D resources to research the general areas since they all should be very concerned for society in improving the general level of understanding of major health effects. These effects should be highly beneficial in improving public understanding.

Q.3 Another amendment by Mr. Broyhill to Section 112 of the Act regarding national emission standards for hazardous air pollutants (NESHAPS) would provide that no new pollutant may be listed prior to independent review by the Clean Air Science Advisory Committee of the pertinent scientific evidence.

What is your opinion of this amendment?

A.3 The Broyhill amendment certainly would improve standard setting under Section 112. In view of the substantial criticism directed at the quality of EPA's scientific decisions, review by CASAC would serve as an important check on the validity of any proposed EPA finding that a substance might reasonably be anticipated to cause death or serious illness. However, a further provision should be inserted requiring EPA to respond to CASAC suggestions regarding the listing of a substance.

Q.4 The National Commission on Air Quality (NCAQ) recommends that within one year EPA should be required to determine whether a fine particulate standard should be established in addition to or instead of the revised total suspended particulate standard.
What would be the effect of this policy on EPA R&D? On industry-wide R&D?

A. 4 The EPA is presently engaged in the task of reviewing an updated criteria document on SO_2 and total suspended particulates which according to the law must serve as the basis for National Ambient Air Quality Standards (NAAQS).

Standards should be based on scientific data available at the time of review, and should not be forced to meet a specified timetable; prior attempts by EPA to generate scientific results to meet regulatory inspired deadlines has contributed to the loss of credibility of the agencies R&D programs which was observed by NCAQ in its comments on page 80 of the NCAQ report.

Based on my reading of the various drafts of the criteria documents made available to the public, the new criteria document can possibly serve to justify a new NAAQS for fine particulates. I would suggest that the recommendation by NCAQ not be construed as a proposal to establish a new mechanism for developing and producing standards, but as a recommendation to the administrator regarding this subject.

In principle, the recommendation should have no effect on EPA R&D nor for that matter on industrywide R&D unless the Administrator, subject to advice from the Clean Air Science Advisory Committee, concludes there is in sufficient scientific evidence available to justify a clear decision. In this case, EPA's R&D program should be revised as necessary to provide such information and data.

Q. 5 The NCAQ recommendations regarding EPA research are that:

a. EPA should take further action to strengthen long-term, anticipatory and basic research through Committees;

b. EPA should appropriate a separate fund solely for emergency actions like Love Canal;

C. EPA should incorporate independent peer review into its internal research program through the Scientific Advisory Board or independent consultants; and

d. EPA should retain its research function, but should bolster and maintain independent reliance on peer review of all health effects research. please comment on these recommendations.

A. 5

a. I agree with NCAQ's recommendation. One of the principal criticisms of EPA research is that it has been over-responsive to short-term regulatory priorities and insufficiently concerned with identifying long-range technical issues and sponsoring the necessary research to justify appropriate regulatory action.

b. I believe that a separate un-earmarked emergency fund, while desirable on the surface, would be likely to exacerbate the present unevenness of EPA R&D programs. Any properly organized research function should be able to make contributions within the range of its expertise to whatever emergency situations arise, without the need to undertake crash programs.

c. An independent peer review committee should be incorporated into the EPA's internal R&D program, if it does not already exist. An even more important action is to subject in-house results to the normal publication, peer review procedures used in the scientific community, rather than publishing results in in-house documents, and then citing them as scientific data supporting subsequent regulatory decisions.

d. I agree.

Q.6 What should be the overall roles of industry and the Federal Government in air pollution R&D in the short-term? In the Long-term?

A. 6 The primary role of government in air pollution R&D should be directed at environmental effects rather than control technology. Among the specific environmental effects which deserve more attention are transformation and transport phenomena, establishing source and receptor relationships, identifying and categorizing chronic effects due to low levels of exposure for long periods of time developing new methodology for improving the precision of measurements and establishing acceptable criteria for damage functions, in both health and welfare related subject matter.

Industry's primary role is to develop cost-effective control technology. In the short run, this usually means end of pipe technology; longer run, it means developing new processes which deal with residuals in the most cost-effective manner and which also meet the criteria of energy and manpower efficiency. Another important industrial R&D objective is to develop improved sensors to detect and measure pollutants and to devise hardware and software to enable efficient process control.

Q.7 Where should industry place its R&D emphasis in air pollution in the short-term? In the long-term?

A. 7 See answer to question 6 above. Both industry and government roles have short and long term components.

Q.8 Where should the Federal Government place its R&D emphasis in air pollution in the short-term? In the long-term?

A.8 The Federal Government should concentrate its R&D efforts towards the following objectives:

1. Identifying and characterize potential long-term global environmental problems.
2. Provide support for long term health and welfare effect R&D.
3. Provide support to academic institutions to develop a resource of trained manpower.

Each objective has both short-term and long-term components.

***

Dr. N. Robert Frank
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Responses to Questions from Congressman Scheuer following the Joint Hearing on the Clean Air Act held by the Subcommittees on Energy Development and Applications and Natural Resources, Agriculture Research and Environment on May 19, 20 and 28, 1981

QUESTIONS

1. Comprehensive amendments were proposed recently by Congressman Broyhill to broaden the data support for issuance of air quality criteria to specific identification of the scientific basis for specific pollutant listing, which would:

a. Include a description of the natural or background level of the pollutant;

b. Determine the validity of scientific acceptability of the design, methodology, analytical techniques, results, and reported conclusions for essential studies;

c. Repeat critical clinical or toxicological studies prior to promulgation of standards if the Administrator or the Clean Air Science Advisory Committee determines that the studies are of questionable validity;

d. Examine the nature, frequency, duration, reversibility, and severity of all demonstrated and confirmed effects on public health and welfare;

e. Analyze the exposure of susceptible individuals to concentrations sufficient to cause adverse effects; and

f. Require approval of the final criteria documents by the Clean Air Scientific Advisory Committee.

How would passage of these amendments change the R&D program at EPA? Industry-wide?

ANSWER TO QUESTION 1

Much of the information specified in proposed amendments 1(a) and 1(b) is conventional in nature, found in recent criteria documents and, along with proposal 1(d), is not likely to impose significant change in EPA's or industry's research programs.

Recent clinical research on SO_2 has indeed shown that susceptible individual (proposal 1(e)), asthmatics in particular, are affected functionally by low concentrations that cause no response in healthy individuals. There is a clear need for additional studies of this type (susceptible populations) involving all regulated pollutants. This need has been stated by a number of advisory groups convened by EPA.

Answer to Question 1 - continued

I would suggest, however, that this proposed amendment (1(e)) might sound the death knell for basic, mechanistic research, both at the Agency and in industry, depending on how "adverse" were defined or interpreted. Were "adverse" limited to permanent or disabling changes, as some have suggested and which I oppose, there would be little incentive to study reversible or subclinical responses even though the latter are often preludes to chronic or disabling disease. ("Adverse" is usually thought of in terms of changes that can be measured by objective laboratory or clinical means; the anxieties and tensions that accompany air pollution and which may be prompted by cough, eye irritation or even a discolored, opaque sky -- mental health -- are discounted.)

EPA has the resources for repeating key or controversial short-term clinical and animal studies (proposal 1(c)). It should be added that such resources are threatened by imminent reductions in staff and budgetary support within R&D. This type of confirmatory research is critically important to any regulatory agency. An amendment to this effect would contribute strong, helpful support for this function.

I find it hard to imagine that EPA would proceed (today) in the absence of approval by CASAC of a particular criteria document. Such an amendment would be viewed favorably by industry and the scientific community, and would probably be accepted with some degree of unease by environmentalists. I doubt that it would have direct influence on research. (One fruitful by-product of the process of producing a criteria document, including CASAC's review, is that the gaps and controversial issues are identified and discussed. This is tantamount to laying out a program of needed research for the Agency.)

2. Another amendment by Mr. Broyhill would change the guiding language for primary clean air standards in Section 109(b)(1) of the Act from "allowing an adequate margin of safety, are requisite to protect the public health," to "are requisite to protect the public health from significant risk of adverse health effects."

What would be the effect of this amendment on the R&D program at EPA? Industry-wide?

ANSWER TO QUESTION 2

See previous comment about 1(e). The evolution of chronic disease (pathogenesis) often proceeds slowly. To understand and to detect the process in its earliest stages, which have implications for both preventive and remedial medicine, requires knowledge about health - or normalcy - as well as about early, reversible responses to environmental stress. The statutory language proposed by Mr. Broyhill is likely to narrow the scope of research qualifying for support, and, thereby, deprives society of vital knowledge.

3. Assuming that EPA continues to have a role in health effects research, what balance would you strike between short-term and long-term research by the Agency?

ANSWER TO QUESTION 3.

While favoring retention of both short-term and long-term research within the Agency, I don't think that a formula designed to maintain balance between two forms of research would be particularly helpful. Both, of course, are necessary. Ideally, they compliment each other. Unfortunately, long-term research is at a disadvantage (see testimony) in a regulatory setting and for this reason, a lower limit or "floor" might be established by Congress.

Examples of complimentary, necessary research:

- With respect to the current ozone (Oz) standard (and the short-term NO_2 standard under consideration), there is in my judgment need for clinical studies (short-term) on individuals with hyper-reactive airways (similar to the clinical research currently being carried out with SO_2), in which exposure is combined with exercise. But there is also need for detailed study of the effect of chronic exposure to Oz on animals. Preliminary evidence suggests that prolonged exposure to Oz results in structural damage to the lungs of animals, including primates, that is akin to accelerated aging and early stages of chronic lung disease. The structural elements of the lungs undergoing these changes (elastic tissue elements) and the site of the damage (small airways and nearby airspaces) are also present in human lungs. In addition, I think that a strategy for assessing the effects of smog episodes in an area such as the Los Angeles Basin should be devised, perhaps based on the case-study method; but to do this will require a long-term effort.
- One could cite examples of the need for additional short-term and long-term research involving other regulated pollutants, i.e., additional information on the effects of CO on persons with vascular disease, which is short-term and critical to both 8-hr. and 1-hr. standards; also, the possible effects of CO combined with altitude on pregnancy and the fetus, which qualifies as long-term research.
- The screening procedures used to test for mutagens, carcinogens, and cell toxins (candidates for regulation under Sections 111(d) or 112) are essentially long-term. The results of the former are vital in planning the latter, which are resource-intensive.

4. Where should the industry place its R&D emphasis in air pollution health effects in the short-term? In the long-term?

ANSWER TO QUESTION 4.

Industry naturally tends to shift its research support to pollutants under consideration for regulatory action. A number of examples could be cited. Recently, the Electric Power Research Institute (EPRI) initiated support of research designed to repeat the study of Sheppard and co-workers, referred to earlier, which demonstrated functional changes in some asthmatics exposed to as low as 0.1 ppm SO_2 during mild exercise. EPRI is also planning to undertake an ambitious program of research on fly ash that will embody short-term and long-term elements. The automotive industry, in part through the auspices of the Coordinating Research Council, has been supporting research on CO, O_2, NO, and airborne particulates. The tension within the industry over the level of control that might be imposed on emissions of particulates from diesel vehicles may have been reduced since EPA discontinued its program on diesel exhausts and with the November elections.

In my judgment, industry is shying away from long-term epidemiologic research. Like most regulators, industrial sponsors are partial to a quick return on investment. Also, air pollution epidemiology is out of favor in many quarters which is in part an aftermath of the CHESS Report.

Regarding where industry might place emphasis in R&D, I would suggest as an important area the improvement of methods for reasonably rapid toxicological screening of new emissions, chemical products and by-products, etc. that might be hazardous to health or ecological systems. Please note that such research is somewhat basic and exploratory in nature and involves a long-term commitment.

5. How do we judge benefits as well as risks in the health effects area?

ANSWER TO QUESTION 5.

While the putative benefits of control can be enumerated fairly easily, only a fraction of them can be expressed in market terms. Some benefits, or alternatively costs of inadequate control, lie in the future. Others cannot be judged other than in ethical, moral and social terms. In the here-and-now, benefits are the obverse of dose-response relations. If dose-response information about harmful effects is available, then the benefits of lowering dose through regulatory action can be predicted with reasonable assurance. But, if there are uncertainties about dose-response relations, they will carry over into the analysis of benefits (and costs).

6. You indicate in your testimony that you have been involved in the research on the effects of air pollutants on the lung.

a. What is the nature of your research?

b. What conclusions have you drawn? What additional research needs to be done in this area?

ANSWER TO QUESTION 6 (a,b)

I have been involved in research on the following:

- Effect of SO_2 on lung function in healthy adult adolescents with asthma, and animals; the sites of absorption of SO_2 within the respiratory system; the metabolic fate of SO_2 following absorption. Conclusions: SO_2, in realistic concentrations, acts principally as an irritant that has virtually no cumulative effect.

- SO_2 is removed from inspired air almost entirely within the upper airways except when, as in exercise, ventilatory rate is increased and oral breathing predominates. In the latter circumstances a significant fraction of the gas penetrates beyond the upper airways. Therefore, short bursts of activity in a polluted environment are likely to have greater effect than long periods at rest. (Children in a playground are at greater risk than adults on beaches.)

- Factors governing synergism (exaggerated effects) between SO_2 and airborne particulates.
  Conclusion: Synergism is more likely to occur when SO_2, which is highly soluble in aqueous solution, mixes with small droplets than with dry particles (dust, for example). This circumstance is favored by high relative humidity.

- Effects of sulfuric acid and the ammoniated salt of sulfuric acid on lung function in animals.(Sulfuric acid is formed when SO_2 is oxidized in ambient air; ammoniated sulfate salts are formed when the acid reacts with ammonia in air.)
  Conclusions: Sulfur acid is the most potent sulfate ordinarily found in ambient air, probably owing to its strong acidity. By comparison, ammonium sulfate is a weak irritant and sodium sulfate is bland. Only a limited but variable fraction of the total sulfate mass in air poses a hazard to health.

  The upper airways produce ammonia capable of neutralizing at least a fraction of inhaled acid particulates and thereby afford some degree of protection to the lower airways and lung tissue.

  Even within a single litter of animals, there are often significant differences in response following short-term exposures to irritants. The reasons for this variation - for theexaggerated response in some animals - are poorly understood. Healthy volunteers are also likely to include a few "hyper-responders".

ANSWER TO QUESTION 6 (a,b) - continued

- Effects of Oz on the lungs of healthy adults and animals; the site(s) of uptake of Oz within the respiratory system.
  Conclusions: The functional and structural effects of Oz, unlike those of SO_2, are distributed throughout the trachio-bronchial tree and periphery of the lung. The most significant structural damage occurs in the periphery.

  Early changes in lung function occur on a localized or regional basis, which may lie beyond detection with conventional tests measuring overall function.

  Penetration of the gas into the lower airways increases with increased ventilatory rate, as in exercise.

  Additional research: Several suggestions have been offered elsewhere in the course of answering other questions. I would add one more suggestion: To determine whether the animals showing the greatest response during short-term exposure are most likely to develop chronic (irreversible) disease if the exposure is prolonged. That is, can we use the results of short-term exposure as markers to predict vulnerability to chronic exposure. Complementary to this effort would be to determine the mechanism for the increased responsiveness/vulnerability.

7. As a participant in the preparation and review of EPA's criteria documents on ozone and combined sulfur oxides-total suspended particulates, would you give your views on:

   a. The validity of the scientific research involved.

   b. The weakeness in the criteria documents from a health effects, research standpoint.

   c. How could the scientific data used be improved? What additional research is needed?

ANSWER TO QUESTION 7 (a, b, and c)

a. It is generally acknowledged that the epidemiological component of these documents, particularly that on sulfur oxides-suspended particulates, has suffered the greatest criticism and loss of credibility. My own judgment is that some of the criticism is overstated. There are no perfect or criticism-free epidemiological studies of air pollution, nor are there likely to be any in the forseeable future (in great measure owing to their complexity and the limited resources that are available). Nonetheless epidemiological research remains critically important.

b. Insufficient evidence on the response of susceptible individuals. They are most likely to be affected by air pollution and - until recently - lease likely to be studied; I refer principally to persons with underlying heart or lung disease and children. There are several reasons for this: Ill persons are less homogeneous and more difficult to characterize than healthy persons in terms of most measurements; consequently, they pose greater problems in experimental design. In addition, there are legal and ethical constraints to performing research on susceptible persons. Indeed, it may be extremely difficult to obtain approval for such research in some institutions.

ANSWERS TO QUESTION 7 (a, b, and c) - continued

c. One problem is editorial in nature and concerns the proper analysis and organization of scientific information. EPA and its teams of authors have been learning, slowly and painfully, how to compose criteria documents: how to analyze, collate, and highlight important material credibly and usefully. Unfortunately criteria documents have grown into indigestible masses of data that show little evidence of judgment or critical insight. The staff paper, produced within the Agency in conjunction with the criteria document, has assumed this task. I think that improvement is underway, prompted in part by CASAC.

A second general problem concerns the special demands placed on confirmatory or regulatory research. Research of this type must be able to withstand quasi-legal scrutiny; weaknesses in any structural component are likely to be dramatized in what is inevitably an adversarial setting. A significant fraction of the research reported in the early criteria documents was probably not designed for regulatory needs; instead it was exploratory or "ground-breaking" in nature.

For additional needed research, see earlier comments.

8. You state in your testimony that the results of long-term exposures of animals to ozone have raised concerns about the ozone standard that cannot be resolved at present by either laboratory or epidemiological studies on humans.

a. Why can these reservations not be resolved?

b. Is more research needed in this area?

c. Is EPA the agency to conduct additional research in this area?

ANSWERS TO QUESTION 8 (a, b, and c)

a. The techniques needed to resolve these questions (methods of testing) cannot be readily administered on a large scale. Epidemiologists usually must rely on simple, non-invasive methods when studying large populations in the field, a practical necessity. These techniques are less sensitive and revealing than those used in laboratory studies.

b. Yes, but note that this will require participation by basic scientists in order to develop new, refined methods of measurement.

c. As I noted in written testimony, such research is tentative and exploratory in nature. In principle EPA can and should be engaged in this research Perhaps the most practical way for EPA to achieve these ends is through its extramural research and contract programs.

9. You state in your testimony that EPA's epidemiology research program has been criticized because of its inability to conduct credible scientific research.

a. Would you elaborate on this statement? What is the nature of this criticism other than the CHESS Report?

b. Is EPA moving to correct the problems that caused the criticism?

c. Is the epidemiology research program at EPA a necessary part of its research?

ANSWERS TO QUESTION 9 (a, b, and c)

a. Apart from the CHESS Report, it is commonly believed that a regulatory agency cannot, or should not, be entrusted with conducting, analyzing, and assessing its own research. In answer to this, I think that effective safeguards are now in place to ensure credible research, i.e., CASAC, the Science Advisory Board, and peer review panels (This is not to say that these groups are being used as well as they might be.)
Secondly, the Agency lacks a corps of competent epidemiologists. This is part of a larger problem: the Agency has difficulty in recruiting and retaining good scientists. The reasons, which have been described in a number of reports, include the following: lack of control by the investigator over the research agenda; heavy administrative and management burdens; lack of a formal dual-promotion ladder (competence in contract management takes precedance over scientific achievement; the individual is under pressure to excell in the former); budgetary instability, which may have cataclysmic consequences for long-term epidemiological research; occasional harrassment through application of public access-to-information laws.

b. The in-house epidemiological program has been dismantled Whatever epidemiology remains will be carried out extramurally. The quality of all research will depend in good measure on the rigorousness of the peer review system. EPA has instituted a promising peer review system for its external grants program, which should be emulated in its cooperative agreements (with centers of excellence) and intramural programs.

It is more difficult to reduce the disincentives to acquiring and retaining good scientists. Here, Congress may have to intervene if progress is to be made.

c. Yes, in my judgment.

10. What changes, if any, should be made in the Clean Air Act? Explain your answer citing evidence, research results, etc.

ANSWER TO QUESTION 10

I see no need for substantial changes in the sections of the Clean Air Act dealing with NAAQS and NESHAPS. One issue concerns the meaning of "adequate" and "ample" margins of safety. Congress, in a statement of legislative intent, could provide clarification; that is, point out that discrete thresholds or no-effects levels for pollutants probably do not exist (see footnote)*. Instead, the Administrator is to arrive at a judgment of what constitutes an adequately (Section 109) or amply (Section 112) safe level, that the judgment is probablistic (some individuals may be affected at any level), and that public health is to be the pre-eminent but not necessarily sole consideration in the decision. Until recently, I thought that the statutory language should be changed to something like "acceptable risk" or "not unreasonable risk". While such a change can be justified rationally, I now consider it to be unnecessary (provided that Congress clarifies its intent) and that it would be viewed by many who resist the change as a severe symbolic defeat, (which is worth avoiding).

Another issue concerns the need for a distinction between "all indentifiable effects" and "adverse effects". I think that Congress should avoid any attempt at making the distinction statutorily, as some have recommended.

Congress should remove or increase the statutory limit on the size of CASAC (seven members). CASAC's tasks are huge and complex. The opportunity to include additional scientific, technical and even non-technical disciplines in its voting membership would help.

The pace of listing and regulating hazardous pollutants under Section 112 has been unacceptably slow. Perhaps Section 111(d) should be modified to facilitate its use in controlling pollutants that do not readily qualify for listing under Sections 108 and 112. In effect, this is a recommendation to substitute a technology-based regulatory approach for the health-based approach of Section 112. The latter may be more desirable in principle, but the acquisition of health-effects information adequate to justify strict standards is a slow, sporadic process that cannot keep up with the appearance of new potentially hazardous substances. Section 111(d) would be appropriate for controlling many non-carcinogens, and perhaps some weak or potential carcinogens. It can be employed to avoid the source-by-source and pollutant-by-pollutant focus of Section 112.

*Footnote: For whatever type of effect is under consideration, there is likely to be a family of thresholds within the population. Age, sex, nutritional status, underlying health, genetic make-up, co-existing pollution, and weather are some factors that may influence the threshold - or response.

11. In your opinion, how could acid rain be brought under control? Please explain.

ANSWER TO QUESTION 11

If acid deposition (including rain) is to be mitigated, there must be some modification of the Act to permit more effective control of interstate (and inter-American) air pollution. In most instances responsibility for interstate pollution can be assigned to regions, not to individual sources. (The air quality models used in state implementation plans trace pollutants only up to 50 km.) Sections 110 and 126, designed to control interstate pollution, are presently inadequate. Section 126 focuses on individual stationary sources, while the language in Section 110 appears ambiguous on this point. Clarification of Section 110 is needed to indicate that regional, not just individual emissions, are to be controlled.* Regional modelling, evidence of damage from acid deposition, and cost/benefit analysis should be used in the process. To be effective, control of existing as well as new sources is probably necessary; that is, NSPS is not likely to be effective alone during the remainder of the century. Modification of the Act should confer on EPA and the downwind states the authorization to force compliance by the emitting states.

* The states in implementing regional emission standards can address source-by-source or category-by-category issues.

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